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ABSTRACT

This instructional unit deals with broadly based appreciation training in a range of skills that are appropriate to a wide sector of occupations, including safety, engineering drawing, engineering materials, bench fitting, sheet metal work, turning, milling, welding, and electricity/electronics. The materials presented are intended for instructors and trainees to use as a reference work and self-teaching aid. The unit includes instructional text on the following topics: engineering drawing; techniques of measuring and marking out; sheet metal work; procedures in milling, turning, and bench fitting; oxyacetylene welding; glass cutting; electrical wiring; and electronic wiring and assembly. Instructor guide notes and trainee guide notes are also included, as well as a skill and training specification checklist. (MN)

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ED285003

Engineering Industry Training Board (EITB)

Foundation Training. Unit 2

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ENGINEERING INDUSTRY TRAINING BOARD

EITB FOUNDATION TRAINING

TRAINEE'S NAME

.....

TRAINING CENTRE

.....

SPECIFICATION FOR UNIT 2

Skill Specification

Training.

1. The safe use and application of a range of machine tools, hand tools and ancillary equipment necessary to carry out the skills listed in the Training Specification.
2. Reading and working to engineering drawings to BS 308 (1972) Parts 1 and 2 (Engineering Drawing Practice).
3. Using measuring and marking out equipment as outlined in the Training Specification in:

   (a) metric units
   (b) imperial units
4. Selecting and using appropriate cutting fluids and lubricants.
5. The application of workholding techniques and the correct methods for the basic practices appropriate to producing workpieces by milling and turning.
6. Using basic bench-fitting techniques to carry out simple operations as listed in the Training Specification.
7. The application of basic tools and equipment for the cutting and forming of thin plate material.
8. The application of basic cutting and welding practices by the oxy-acetylene and manual metal-arc processes.
9. Understanding the basic principles of electrical/electronic practices; and identifying, mounting and connecting simple electrical and electronic components.

Note: It should be possible for trainees to achieve at least the following standards at this stage of First-year training.

Operation	Tolerance	Surface Texture
Bench fitting	±0.25mm or ±0.010ins	1.6 µm 63 µin
Machining	±0.25mm or ±0.010ins	1.6 µm 63 µin
Marking out	±0.4mm or ±0.015ins	
Bending and forming sheetmetal	±1.5mm or ±0.060ins	

TRAINING SPECIFICATION

This Training Specification specifies the training which should be undertaken during Unit 2 of EITB Foundation Training.
Before commencing to work to this Specification you should already have undertaken training to a Unit 1 Skill and Training Specification.
The boxes provided on the right-hand side of each page are to allow a record to be kept of your training.

Column A is for recording practices of skills during the Unit 2 training period.

Column B is for indicating that you have achieved an acceptable level of performance in the particular skill to the standards shown in the Unit 2 Skill Specification.

Column C is for recording practices carried out to an acceptable standard during Unit 1 training (see Instructor Guide Notes) and your Instructor may decide to exempt you from any further practice in that skill area.

At the end of your training in Unit 2 the marked-up Training Specification and Work Record Book will provide useful evidence of the work you have done and the standards you have achieved during Foundation Training.

SAFETY The trainee must be given induction and safety training in all skill areas which form part of the programme irrespective of any previous training.

The trainee must have an understanding of the Workshop Statutory Requirements with regard to:

(a) Statutory requirements

The Abrasive Wheel Regulations 1970			
The Protection of Eyes Regulations 1974			
The Health and Safety at Work etc Act 1974			
The Factories Act 1961			
The Electricity (Factories Act) Special Regulations, 1908 and 1944			

(b) Workshop requirements

First aid procedures			
Accident procedures			
Fire hazards and fire fighting procedure			

(c) Personal protection

Protective clothing			
Manual lifting techniques			
Personal hygiene			

Engineering Drawing

		A	B	C
Understanding the basic drawing conventions and symbols to British Standard Specification BS 308	Dimensions			
	Abbreviations			
	Manufacturing tolerances			
	Surface texture			
Understanding simple orthographic drawings	1st angle projection			
	3rd angle projection			
Making simple isometric sketches from	Objects			
	Orthographic drawings			
Understanding sectional views				
Reading simple component drawings and extracting information correctly	Type of material required			
	Size and shape of material			
	Shape of component			
	Operations necessary			
	Dimensions and tolerances			
	Surface finish			

Measuring and marking-out

Measuring, using	Rules/tapes			
	Calipers			
	Protractor			
Using	Radius gauges			
	Feeler gauges			
Measuring, using	External micrometers			
	Vernier calipers			
Checking machined surfaces using	Surface texture plates			

Marking out, using	Rules			
	Centre punch/scriber			
	Dividers			
	Scribing block			
	Squares			
	Protractor			
	Surface table/plate			
Marking out	Datums/guidelines			
	Angles			
	Radii/circles			
	Hole positions			

Turning

Identifying and safely using machine controls				
Selecting, setting and using cutting tools				
Selecting and setting speeds/feeds				
Selecting and using coolants				
Mounting and using	3 jaw chucks			
	4 jaw chucks			
	Driving plate and centres			
Facing	To the centre of the work			
	A shoulder			
	To length			
Turning diameters	External			
	To a shoulder			
Centre drilling				
Drilling	Through workpiece			
	To a depth			
Reaming				
Knurling				
Taper turning using compound slide				
Thread cutting using	Taps			
	Dies			
Boring	Through workpiece			

Milling using Vertical or Horizontal Machines

Identifying and safely using machine controls				
Selecting and mounting cutters	On arbors			
	In collet chucks			
Selecting and setting	Speeds			
	Feeds			
Selecting and using coolants				
Positioning and securing	Vice to machine table			
	Workpiece in vice			
Positioning workpiece to cutter using	Machined faces			
	Marking out			
Milling faces	Horizontal			
	Vertical			
Milling stepped faces				
Milling slots	Open ended			
	Enclosed			
Milling faces having an angular relationship	Single angle			
	Vees			

Bench-fitting

Selecting and safely using hand tools				
Safely using	Drilling machines			
	Grinding machines (off-hand)			
	Shaping machine			
Using	Cutting fluids/compounds			
Filing surfaces	Flat and square			
	Curved			
	Angular			
Removing surplus material by	Sawing			
	Chiselling			
	Shaping			
Producing holes by	Drilling			
Finishing holes by	Reaming			
	Counterboring			
	Countersinking			
Producing threads, using	Taps			
	Dies			
Fitting mating parts by	Filing			
	Scraping			
Off-hand grinding centre punches and scribers				

Sheet Metal Work

Selecting and safely using hand tools				
Cutting thin plate using	Hand/bench shears			
	Guillotine			
Bending	Upstands			
	Box/tray sections			
Flanging	Boxes or cylinders			
Hemming	Single edges			
Wiring	Flat or curved edges			
Forming	Cylinders or cones			
Making a self secured joint				
Producing holes, using	Portable drill			
	Bench/pedestal drill			
Joining, using	Mechanical fasteners			
	Rivets			
	Solder			

Oxy-acetylene Welding

Safely operating oxy-acetylene welding equipment				
Producing fusion without filler				
Depositing a straight run with filler	Flat position			
	Vertical position			
Tack welding				
Welding in flat position	Close square tee fillet			
	Close outside corner			
	Square edge open butt			

Manual Metal-Arc Welding

Safely operating manual metal-arc welding equipment				
Striking and breaking the arc				
Depositing a straight run				
Tack welding				
Welding in flat position	Close square tee fillet			
	Close outside corner			

Gas or Arc Cutting

Safely operating cutting equipment				
Hand cutting	Straight lines, square edge			
	Straight lines, bevel edge			
	Simple shapes			

Materials

Identifying	Ferrous metals			
	Non-ferrous metals			
	Non-metallic materials			
Heat treating materials for	Hardening			
	Tempering			
	Annealing			

Electrical Wiring

Understanding basic electrical principles and safety procedures				
Reading electrical drawings	Circuit diagrams			
	Wiring diagrams			
Identifying and selecting cables				
Terminating and connecting cables and flexible cords	Soldered terminations			
	Solderless terminations			
Identifying electrical components				
Mounting components	Correct location/orientation			
Wiring circuits containing basic components	Plugs			
	Sockets			
	Switches			
	Fuses			
Testing electrical wiring for	Continuity			
	Insulation			

Electronic Wiring and Assembly

Reading electronic drawings	Circuit diagrams			
	Wiring diagrams			
Identifying	Wires/cables			
	Basic electronic components			
	Component boards			
	Component markings			
Mounting basic electronic components				
Soldering basic electronic components to component boards				
Terminating cables/wires to component boards and connectors				
Checking battery-operated circuits	Current			
	Voltage			
	Resistance			

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EITB FOUNDATION TRAINING

INSTRUCTOR GUIDE NOTES

UNIT 2

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INSTRUCTOR GUIDE NOTES

UNIT 2

1 Introduction

1.1 These guide notes have been produced to provide further assistance to instructors and tutors who are using EITB Foundation Training Units within a Youth Training Scheme programme.

1.2 A YTS Course consists of a number of related elements designed to provide a coherent programme of basic training and education. When EITB Foundation Training Units are incorporated in the course it will have a bias towards engineering.

1.3 Each EITB Foundation Training Unit is designed for off-the-job training in a workshop which has been specially equipped to provide the facilities necessary for the introduction to basic engineering oriented skills. Off-the-job training is linked with work experience during which the trainee will undertake suitable tasks in a company or organisation and will learn about the way in which industry is structured and operates. At this stage trainees should already have completed Unit 1 training and some work experience.

1.4 A component of further education, usually on a day release basis throughout the year, is also included in the scheme so that trainees can receive further tuition in subjects such as numeracy, communication, life and social skills, and basic engineering principles.

1.5 The Board has prepared Skill and Training Specifications to cover off-the-job training. The second period of such training is described in Unit 2.

1.6 All trainees should have received adequate induction training (see Appendix I). It may be necessary to reinforce some items at this more advanced stage of training, particularly in relation to safety.

2 Unit 2 Training (Off-the-job)

2.1 This Unit deals with the development of the broadly-based appreciation training received by trainees during Unit 1 and introduces further skills and higher standards in each of the skill areas covered. The range of skills continue to be appropriate to a wide sector of engineering.

2.2 Off-the-job training takes place in a workshop area set aside for training with qualified instructors and appropriate equipment.

2.3 A Training Guide No 2 has been prepared to give guidance on methods and job knowledge. This guide should be used in conjunction with Training Guides Nos 1A and 1B which were provided for the Unit 1 training.

2.4 The set of guides is intended for use by instructors and trainees as a reference work and self teaching aid. The booklets describe techniques and skills by the use of illustrations and short text. The methods described are not the only ones which may be used and where other methods are used instructors are urged to check that these are safe and efficient before being used by trainees.

2.5 Attention must continue to be drawn to the importance of safety. It is essential to develop safe working habits from the start as an integral part of training. Safety points are emphasised throughout the text. Before commencing Unit 2 training, trainees should be instructed to read again pages 1 to 15 of Training Guide No 1A.

2.6 In order to assist in programme preparation and to monitor the progress of each trainee, the Board has produced a Skill and Training Specification for Unit 2. This specification identifies the practice requirements for trainees in each of the subject areas for this period of training.

2.7 The time required to complete the Unit 2 Training Specification will depend upon the ability of each trainee and whether Unit 2 standards are achieved. Trainees completing Unit 2 within the allocated time may proceed to more advanced skills and standards.

3 Implementing Unit 2 Training

3.1 At the commencement of Unit 2 training each trainee must have:

A marked-up Unit 1 Skill and Training Specification

Training Guides Nos 1A and 1B

The Work Record Book used during Unit 1 training

3.2 Each trainee is issued with a Unit 2 Skill and Training Specification and Training Guide No 2.

3.3 Trainees should be programmed to subject areas for appropriate training periods as in Unit 1.

3.4 Adequate emphasis must be given to safety and safe working practices at all stages of training.

3.5 Instructors should prepare a work programme for their own sections based on the appropriate time periods to ensure that the trainees have maximum practices of the skills identified in the Training Specification and receive the relevant instructional content.

4 Monitoring Unit 2 Training

4.1 Columns of boxes are printed against each of the skills listed in the Unit 1 Training Specification.

4.2 Before Unit 2 training commences all these skills which a trainee has achieved to Unit 1 standards and recorded in Column B of the Unit 1 Training Specification should be marked in Column C of the Unit 2 Training Specification. These entries may, at the instructor's discretion, exempt a trainee from any further practice in that skill, although if the Unit 2 standard is to be achieved further practice may be required.

Example from Unit 2 Specification - Turning

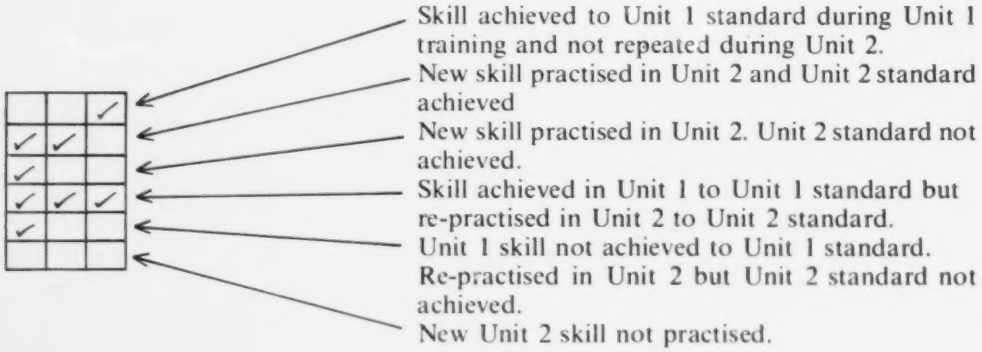
		A	B	C
Turning diameters	External			✓
	To a shoulder			
Centre drilling				✓
Drilling	Through a workpiece			✓
	To a depth			
Reaming				

4.3 During this training period Column A of the Unit 2 Training Specification is ticked to indicate each of the skills which is practised by the trainee.
Column B is ticked if the trainee achieves an acceptable level of performance to the standards shown in the Unit 2 Skill Specification.

Example from Unit 2 Specification - Bench Fitting

		A	B	C
Filing surfaces	Flat and Square			✓
	Curved	✓	✓	
	Angular	✓		
Removing surplus material by	Sawing	✓	✓	✓
	Chiselling	✓		
	Shaping			

The above example shows:


Skill achieved to Unit 1 standard during Unit 1 training and not repeated during Unit 2.
New skill practised in Unit 2 and Unit 2 standard achieved
New skill practised in Unit 2. Unit 2 standard not achieved.
Skill achieved in Unit 1 to Unit 1 standard but re-practised in Unit 2 to Unit 2 standard.
Unit 1 skill not achieved to Unit 1 standard. Re-practised in Unit 2 but Unit 2 standard not achieved.
New Unit 2 skill not practised.

As in Unit 1, this period of training is only appreciation training and it is not compulsory for the trainee to achieve the specified skill standard.
However, where Unit 2 standards have been achieved and recorded in Column B, these will be useful if, at some future date, the trainee enters formal engineering skill training.

4.4 Trainees are expected to continue to keep a work record in their log books for each task undertaken and the reference number of those entries which show achievement of Unit 2 skill standards may be entered in Column B instead of ticks.

Example from Unit 2 Specification - Bench Fitting

Filing surfaces	Flat and square			✓
	Curved	✓	22	
	Angular	✓		
Removing surplus material by	Sawing	✓	18	✓
	Chiselling	✓		
	Shaping			

5 Trainee Assessment

5.1 As well as recording the standards which the trainee achieves in the skill aspects of the Unit 2 training period, the instructor is required to assess the trainee in a range of other basic abilities in order to produce a Unit 2 Profile Record (see Appendix II). An assessment sheet is provided which lists a range of abilities including Social Abilities, Communication, Decision-making abilities, Practical Abilities and shows four levels of achievement in each of fourteen headings. Each copy is signed and dated by the instructor as each level is achieved during the training period.

5.2 Evidence of levels of abilities reached by the trainee at the end of Unit 2 training will be useful to a prospective employer.

5.3 The instructor should keep a Progress Report (See Appendix III) on each trainee.

6 Further Education

Trainees should continue to attend a college of further education during the year and undertake an appropriate course which includes tuition on life and social skills, numeracy and communication as well as technical subjects. This course should normally be attended on a day release basis.

FOUNDATION TRAINING PROGRAMME
INDUCTION CHECK LIST

The main objectives of induction training are to:

a) give the trainee an understanding of the training programme
b) assist the trainee to adjust to the 'off-the-job' workshop
c) assist the trainee to adjust to a company environment.

To ensure that the main topics of induction are covered, the following check list may be used. Each topic as completed should be ticked by the trainee and on being fully completed should be signed by the trainee and supervisor.

Some items may already have been satisfactorily completed during Unit 1.

Location - 'Off-the-job' Workshop	**✓ on completion**
Purpose of Programme	
Content of Programme	
General Safety Requirements	
Documentation	
Financial Arrangements	
Training Materials and Records	
Further Education	
Certification	
Workshop rules and regulations	
Tour of the Workshop, Toilets, Canteen, and other facilities	
Welfare and medical facilities	

Trainee's Signature: .....
Supervisor's Signature: .....

Location - Company Premises	**✓ on completion**
Purpose of Programme	
Work Experience	
Documentation	
Financial Arrangements	
Further Education	
Log-book Record	
General Safety	
Company Rules and Regulations	
Job Responsibilities	
Tour of Works, including Medical Room, Toilets and Canteen	
Welfare and medical Facilities	

Trainee's Signature: .....
Supervisor's Signature: .....

ATTAINMENTS IN BASIC ABILITIES

		4 (Basic Level)	3	2	1 (High Level)
SOCIAL ABILITIES	WORKING WITH COLLEAGUES 1	Can co-operate with others when led	Can work with other members of group to achieve common aims	Understands own position and results of own actions with a group	Is an active, decisive member of group. Helps and encourages others
	WORKING WITH THOSE IN AUTHORITY 2	Can follow verbal instructions for sample tasks and can perform them under supervision	Can follow a series of verbal instructions and carry them out independently	Can carry out a series of tasks effectively, given minimum instructions	Inspires confidence in those in authority and communicates well with them
	SELF-AWARENESS 3	Is aware of own personality and situation	Can determine own strengths, weaknesses and preference with some guidance	Has good basic understanding of own situation, personality and motivation	Has a thorough understanding of own personality and abilities and their implications
COMMUNICATION	TALKING AND LISTENING 4	Can hold conversations with workmates, face to face or by phone. Can take messages	Can follow and give simple descriptions and explanations	Can communicate effectively with a range of people in a variety of situations	Can present a logical and effective argument. Can analyse other's arguments
	READING AND WRITING 5	Can understand and write simple notices, labels and short notes	Can follow and give straightforward written instructions and explanations	Can use instruction manuals and can write reports describing work done	Can select and criticise written data and use it to produce own written work
	VISUAL UNDERSTANDING 6	Can interpret simple signs and indicators	Can, after guidance, make use of basic graphs charts, tables, drawings, etc.	Can interpret and use basic graphs, charts, tables and drawings unaided	Can construct graphs etc and extract information to support arguments
DECISION-MAKING ABILITIES	...NING 7	After demonstration, can identify the sequence of steps in a routine task	Can choose from given alternatives the best way of tackling a task	Can modify/extend given plans/routines to meet changed circumstances	Can create new plans/ routines from scratch. using all sources of help
	INFORMATION SEEKING 8	Can find information with guidance from supervisor	Can use standard sources of information	Can assemble information from several sources	Shows initiative in seeking and gathering information from a variety of sources
	COPING WITH PROBLEMS 9	With guidance, can cope with simple, everyday problems	Can cope with complex but routine problems. Seeks help if needed	Can cope with unusual problems by adapting familiar routines independently	Can offer sensitive and effective help to other people facing problems
	EVALUATING RESULTS 10	Can assess own results with guidance. Asks for advice	Can assess own output for routine tasks independently	Can assess own performance and identify possible improvements	Can identify other's difficulties and so help to improve group performance
PRACTICAL & NUMERICAL ABILITIES	USING EQUIPMENT 11	After demonstration, can use equipment safely to perform simple tasks	With guidance, can use equipment safely to perform multi-step tasks	Can select and use suitable equipment and materials for the job, without help	Can set up and maintain equipment. Can identify/ remedy common faults
	DEXTERITY AND COORDINATION 12	Can use everyday implements, can lift, carry and set down objects as directed	Can reliably perform basic manipulative tasks	Can perform complex tasks requiring accuracy and dexterity	Can perform tasks requiring a high degree of manipulative control
	MEASURING 13	Can read graduated linear scales and dials	Can measure out specified quantities of material by length, weight etc.	Can set up and use simple precision instruments	Can set up and use complex precision instruments
	CALCULATING 14	Can identify size, shape, order etc. Can add and subtract whole numbers	Can use +/-/×/÷ to solve single step, whole number problems. Can estimate	Can use +/-/×/÷ to solve two-step problems. Can add and subtract decimals	Can use +/-/×/÷ to solve multi-step problems. Can multiply and divide decimals

PROGRESS REPORT

Name .....

1st Period

EFFORT

Lazy — Industrious

1 2 3 4 5

CONDUCT

Irresponsible — Responsible

1 2 3 4 5

WORK RATE

Low — High

1 2 3 4 5

ABILITY

Failing Objectives — Achieving Objectives

1 2 3 4 5

2nd Period

EFFORT

Lazy — Industrious

1 2 3 4 5

CONDUCT

Irresponsible — Responsible

1 2 3 4 5

WORK RATE

Low — High

1 2 3 4 5

ABILITY

Failing Objectives — Achieving Objectives

1 2 3 4 5

3rd Period

EFFORT

Lazy — Industrious

1 2 3 4 5

CONDUCT

Irresponsible — Responsible

1 2 3 4 5

WORK RATE

Low — High

1 2 3 4 5

ABILITY

Failing Objectives — Achieving Objectives

1 2 3 4 5

4th Period

EFFORT

Lazy — Industrious

1 2 3 4 5

CONDUCT

Irresponsible — Responsible

1 2 3 4 5

WORK RATE

Low — High

1 2 3 4 5

ABILITY

Failing Objectives — Achieving Objectives

1 2 3 4 5

Signed .....

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EITB FOUNDATION TRAINING

TRAINEE GUIDE NOTES

UNIT 2

TRAINEE'S NAME

.....

TRAINING CENTRE

.....

Engineering Industry Training Board YT 24

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Appendix I
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1 Introduction

1.1 These guide notes have been produced to explain the purpose and details of the EITB Foundation Training Units and to assist you in using the training material which is provided.

1.2 The EITB has prepared Skill and Training Specifications for off-the-job training periods which may be incorporated in a Youth Training Scheme programme. The second of these is explained in detail in this booklet and is known as Unit 2.

1.3 You will already have received Unit 1 training in a workshop and have completed some work experience. The subjects which were covered in your induction training need to be remembered and you should ask your instructor to explain any points which are not clear to you. Safety matters will continue to be of great importance at this more advanced stage of training.

2 Unit 2 Training (Off-the-job)

2.1 This unit deals with the development of the broadly-based appreciation training you have already received during Unit 1 and to introduce further skills and higher standards in each of the subjects covered. The range of skills continue to be appropriate to a wide sector of engineering.

2.2 Off-the-job training takes place in a workshop set aside for training with qualified instructors and suitable equipment and machines.

2.3 The Skill and Training Specification Unit 2 contains details of the training which you will undertake and provides a record of your achievements.

2.4 A Training Guide No 2 has been prepared to give guidance on the methods and job knowledge which you will use during the Unit 2 period. This guide should be used in conjunction with Training Guides Nos 1A and 1B which were provided for the Unit 1 training.

2.5 The guides will be used by your instructor when teaching you skills and you will be able to refer to it to clarify any points which are not clear to you. As the methods shown are not necessarily the only way in which a skill may be performed, your instructor may prefer to demonstrate another method. Your instructor will make sure that it is safe and efficient before instructing you.

2.6 Attention is drawn to the importance of safety and it is essential that you continue to develop safe working habits throughout your training. Read the 'Safety' section of Training Guide No 1A again as soon as possible.

2.7 The time required to complete the Unit 2 Training Specification will depend upon your ability and the standards you can achieve. If you complete Unit 2 training within the allocated time you may proceed to more advanced skills and higher standards.

3 Monitoring Unit 2 Training

3.1 The Training Specification specifies all the items which should be undertaken while working to Unit 2 in an off-the-job workshop.

3.2 Against each of the items in the specification you will find a series of boxes which will be used to indicate that you have practised each item and whether you have achieved the standard shown on the Skill Specification.

3.3 Before Unit 2 training commences all those skills which have been achieved to the Unit 1 standards and recorded in Column B of the Unit 1 Training Specification should be marked in the appropriate box of Column C in the Unit 2 Specification. These entries may exempt you from any further practice in that skill unless you are required by your instructor to achieve the new standard shown on the Unit 2 Skill Specification.

3.4 Your instructor will help you fill in these boxes as you progress through the training programme.

4 Work Record Book

4.1 The work record book which has already been provided should continue to be used to show the work items that you undertake during your Unit 2 training.

4.2 Each entry should show a sketch of the job which you undertake, details of dimensions, materials and operations, and any special features which you may wish to note. Each entry should be given a reference number which may be recorded in the appropriate box on your Training Specification. As you do more advanced jobs each entry may refer to a number of different skill items. Continue to keep your entries neat and clear.

5 Trainee Assessment

5.1 As well as recording the standards which are achieved against each skill item, your instructor will also assess the other abilities which we consider necessary for you to work effectively in industry.

5.2 Your instructor will consider your ability to work with others, to communicate, to solve problems and make decisions, and the way in which you carry out practical tasks. These will be marked at different levels and as you progress during training your improvements will be noted on the assessment form (see Appendix I).

5.3 The levels of ability which you have reached by the end of Unit 2 training will be useful if, in the future you proceed to formal skill training as a trainee employed in the engineering industry.

6 Further Education

You will already be attending a course of further education and it is important that this continues throughout the course. Further education is an essential part of engineering skill training.

7 Work Experience

During work experience you should begin to note how skills which you have developed in Units 1 and 2 fit into engineering activities.

8 General

If you are in any doubt about your work programme or have other problems do not hesitate to inform your instructor.

TRAINEE PROFILE RECORD (UNIT 2)

Name of trainee..... Date of Birth .....

When completed, this profile will show the various levels which the trainee has reached on leaving the course.

As the trainee improves in abilities and skills, the instructor will initial and date the box indicating the level reached.

The instructor has a detailed definition of each of the four levels of achievement.

		4 (Basic Level)	3	2	1 (High Level)
SOCIAL ABILITIES	WORKING WITH COLLEAGUES 1				
	WORKING WITH THOSE IN AUTHORITY 2				
	SELF-AWARENESS 3				
COMMUNICATION	TALKING AND LISTENING 4				
	READING AND WRITING 5				
	VISUAL UNDERSTANDING 6				
DECISION-MAKING ABILITIES	PLANNING 7				
	INFORMATION SEEKING 8				
	COPING WITH PROBLEMS 9				
	EVALUATING RESULTS 10				
PRACTICAL & NUMERICAL ABILITIES	USING EQUIPMENT 11				
	DEXTERITY AND COORDINATION 12				
	MEASURING 13				
	CALCULATING 14				

E I T B **Foundation Training – Unit 2**

TRAINING GUIDE No. 2

This Training Guide contains training material which supplements that published in Training Guides Nos. 1A and 1B. All three Training Guides will be required by trainees undertaking Unit 2 of EITB Foundation Training.

ENGINEERING INDUSTRY TRAINING BOARD **YT 21**

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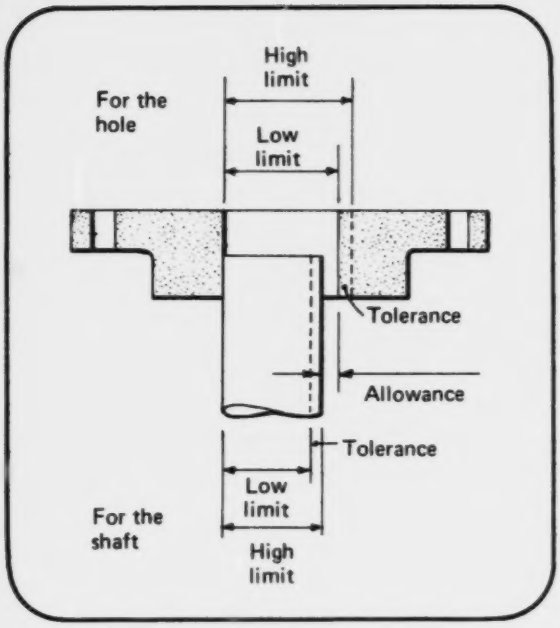
Engineering drawings

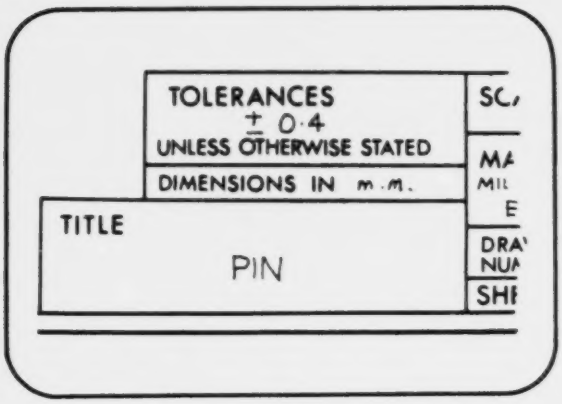


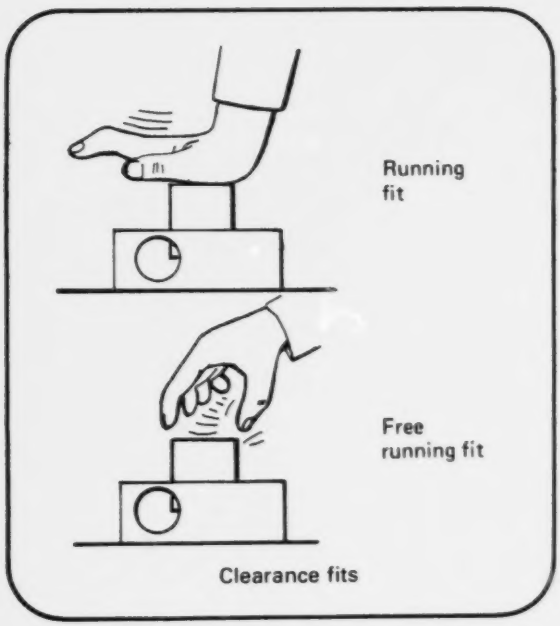
Two of the items indicated by engineering drawings are manufacturing tolerances and surface texture. These are illustrated on pages 17 and 18 of Training Guide No. 1A.

Manufacturing tolerances
When making assemblies of several parts, steps have to be taken to ensure that parts fit together properly. To ensure that similar parts can be interchanged, limits of size are set. These vary with the class of fit required.

Limits and tolerances
The biggest tolerated increase in size above a given dimension is known as the 'high limit'. The tolerated decrease of size below the same required dimension is called the 'low limit'. The difference between the high and low limits is known as the tolerance.

Example
A tolerance of plus or minus 0.4mm (generally shown as ± 0.4) applied to a component dimension of 40mm indicates that it must be manufactured between the limits of 40.4 to 39.6mm.





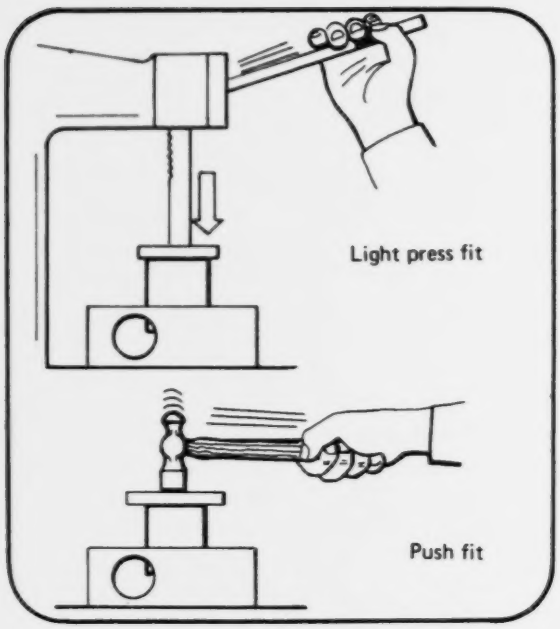
Allowances and fits
When two components are fitted together, such as a shaft and bearing, the difference between the 'high limit' of the shaft and the 'low limit' of the bearing hole is known as the ALLOWANCE.

This allowed difference determines which CLASS of fit exists between the mating parts.

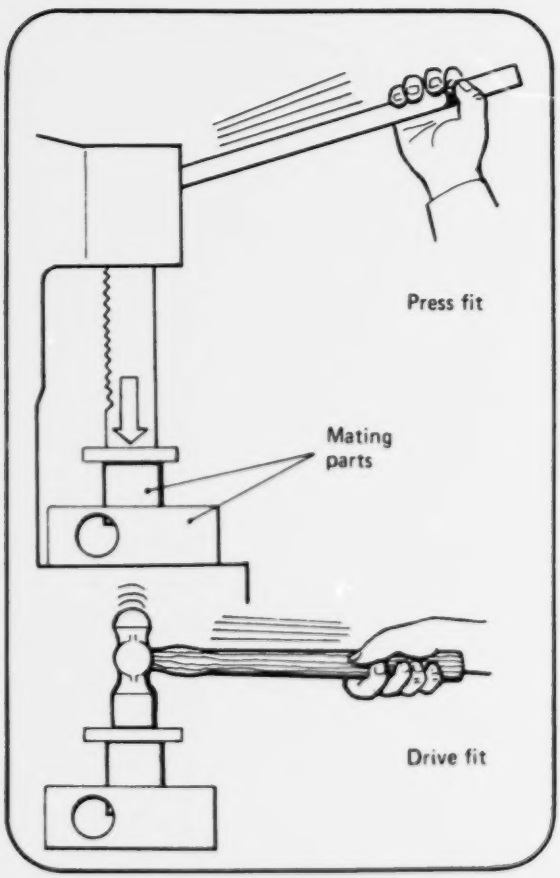
The three classes of fit are:

Clearance
Transition
Interference

Clearance fits may be referred to as running or free running fits. Mating components may be assembled by applying a light pressure or they may fit together without any applied force.

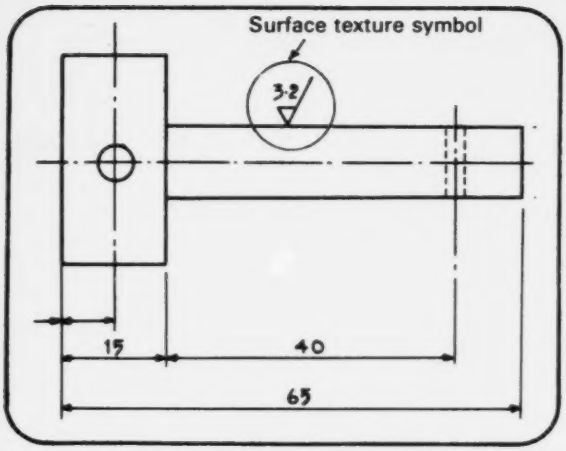


Transition fits may be referred to as light press or push fits. Since there may be interference or clearance between the mating parts they may need a light press or a hammer tap to achieve assembly.



Interference fits may be referred to as drive, press or force fits. The tightness of the fit is unlikely to damage or overstrain components but requires a press or hammer for assembly.

Engineering drawings



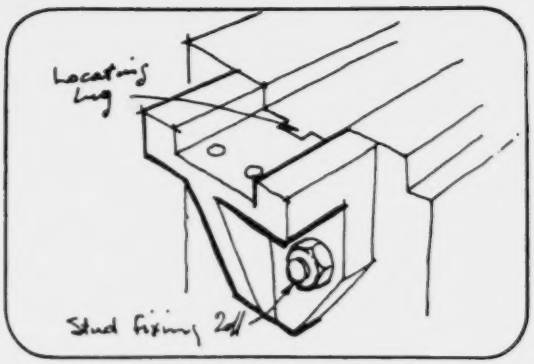
Surface texture - indicated by a symbol as shown on the illustration.
The figure above the symbol indicates the "smoothness" of the surface and is known as the CLA index.

Centre Line Average Index
The Centre Line Average (CLA) index is an accepted method of measuring surface finish.

This expresses a measure of surface finish in micro-inches (micro = one millionth part) and the following tables gives a series of surface textures which can be produced by various manufacturing processes.

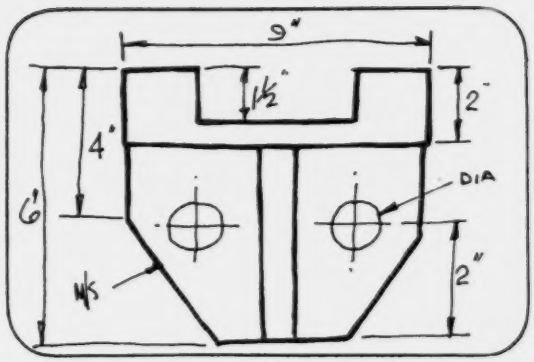
Process	µin Ra (height of irregularities in micro-inches) (1 micro-inch = 0.000001 inch)					
	8	16	32	63	125	250
Drill				■	■	■
Grind	■	■	■	■		
Ream			■	■		
Turn			■	■	■	
Mill			■	■	■	■
Shape				■	■	■
	0.2	0.4	0.8	1.6	3.2	6.3
	µm Ra (height of irregularities in micro-metres) (1 micro-metre = 0.000001 metre)					

The metric equivalent of the Centre Line Average index is expressed in micro-metres.



Freehand sketching

If parts are to be made, or an installation planned, it is always advisable to draw a sketch before commencing work. This is useful in planning the work and calculating the materials needed.

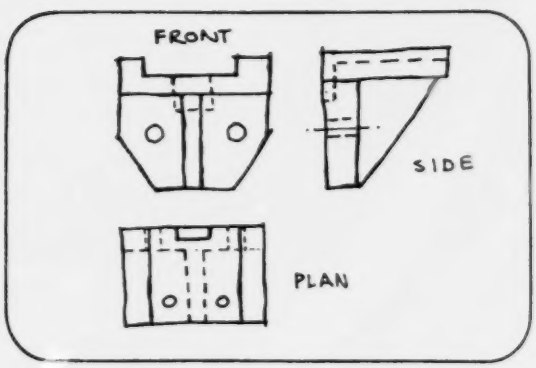


If measurements are taken accurately, and shown correctly, a freehand sketch need not be exactly in proportion. It must be clear and neat to prevent error in reading from it. Symbols used should adhere to BS 308.

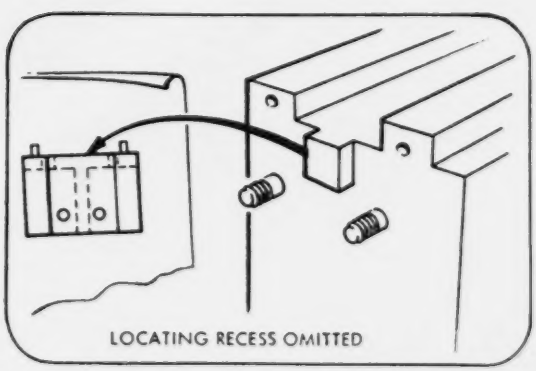
Making a sketch

(a) Use cleanest paper available and a sharp pencil or ball-point pen. Rest the work on a flat surface or support it firmly.

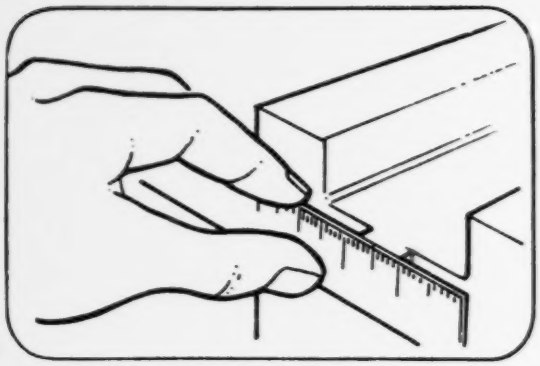
(b) Attempt to keep the drawing as clean and clear as possible.



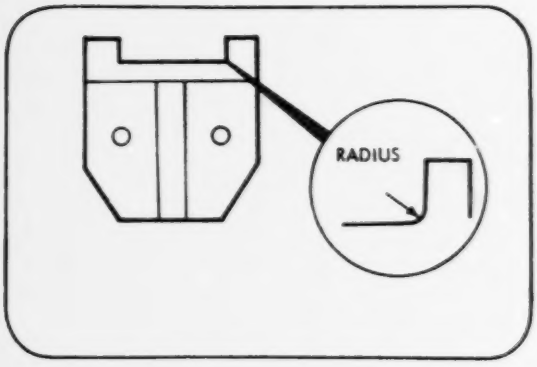
(c) Make rough sketches to decide what views are necessary.



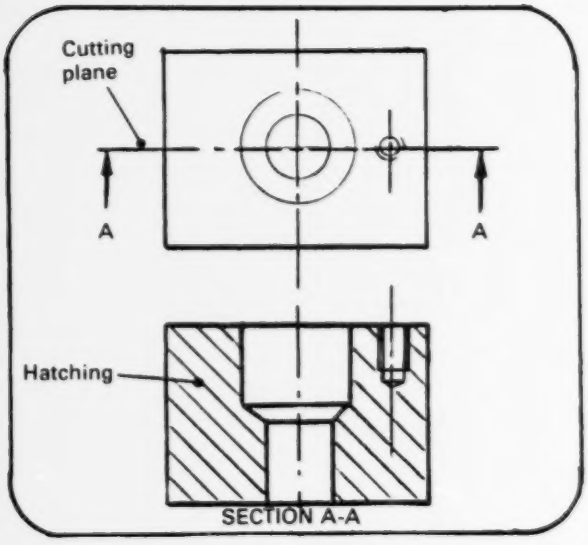
(d) When shapes are complete, check carefully against existing objects for omissions.



(e) Take measurements and mark on sketch.



(f) Make an enlarged sketch of detail where necessary.



Sectional views

These are "cut-away" views showing internal details of a component which cannot be seen on a conventional drawing. The position of the cutting plane is indicated on the drawing and material which has been sectioned is "hatched".

Operations necessary

The operations required to manufacture a component and the sequence in which they are carried out may be decided from the drawing.

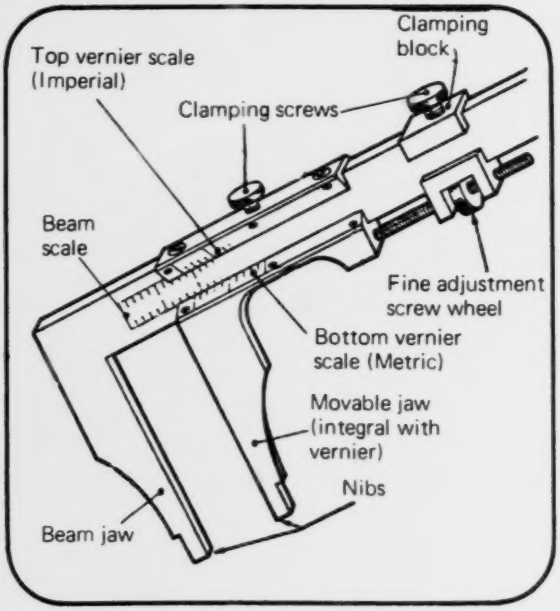
When considering operations the following points must be taken into account:

Size and shape of available raw material.

Methods of holding raw material while machining.

Surface texture required and the method of producing it.

Allowances to be made for subsequent operations.



Vernier caliper gauges

The vernier caliper is an alternative to the micrometer for measuring internal and external dimensions to an accuracy of 0.025mm (0.001in).

Care of vernier caliper gauges

1. Clean instrument before use and ensure that sliding members move freely.

2. Do not use undue pressure as inaccuracies caused by the springing of the jaws can occur.

3. Parallelism of the jaws can be checked by holding the jaws together under very light pressure and viewing the gap, if any, against a light source.

4. For internal work, the nibs should be examined for wear, and a micrometer used to check the allowance to be made for the nibs, or the accuracy of the "internal" scale, if fitted.

To measure using a vernier caliper gauge

1. Check that the two clamping screws are released.

2. Hold the instrument in one hand, the thumb rested on the fine adjustment screw wheel.

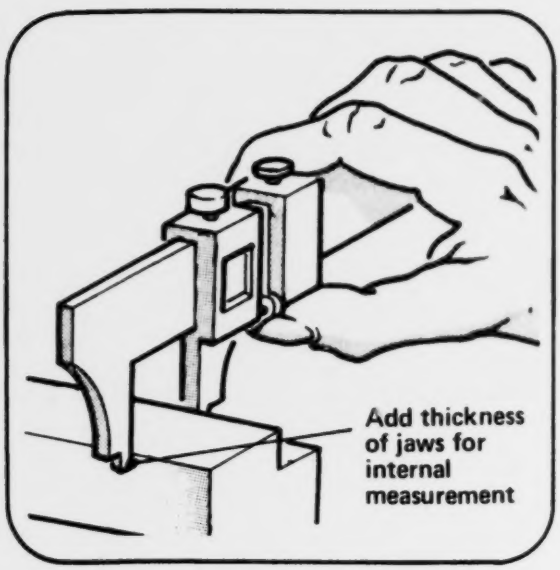
3. Slide the movable jaw forward by extending the thumb until the jaws make contact with the workpiece.

4. Using the other hand lock the screw located in the clamping block.

5. Adjust the movable jaw using the fine adjusting screw wheel. The jaws should just grip the workpiece without undue pressure on the adjusting screw.

6. Turn the screw that clamps the vernier.

7. Remove the caliper (if practicable) and read the dimension in good light.



The following explanations apply to a dual purpose instrument with an Imperial vernier scale at the top and a metric scale at the bottom of the beam scale.

The vernier caliper gauge (metric)
On the beam bottom scale the distance 0 to 1 is 10mm and is divided into 10 parts (1mm). Each mm is further divided in two (½mm). (FIG. 1).

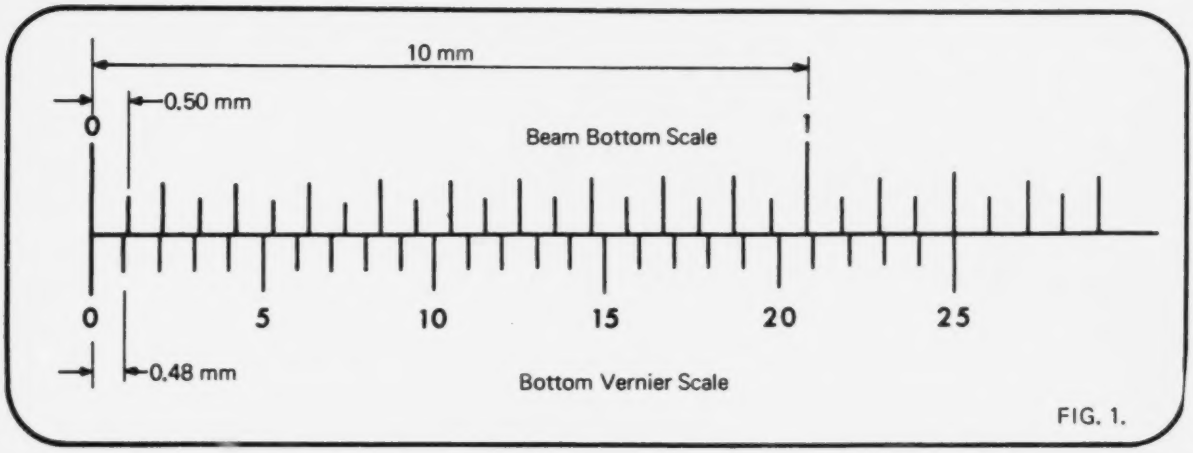


FIG. 1.

On the bottom vernier scale, 12mm is divided into 25 parts, thus each division is 12/25 = 0.48mm.
Note that every fifth division is numbered. (FIG. 1).
Thus, the difference in length between one small division on the beam bottom scale and one division on the vernier scale is:
(½mm) 0.50mm — 0.48mm = 0.02mm.

Example
If the two zero marks are level and the bottom vernier is then moved until the first small marks are level, the movement is 0.02mm; if the bottom vernier is moved until the 15th mark is level with a mark on the beam bottom scale the movement is 15 x 0.02 = 0.30mm (FIG 2).

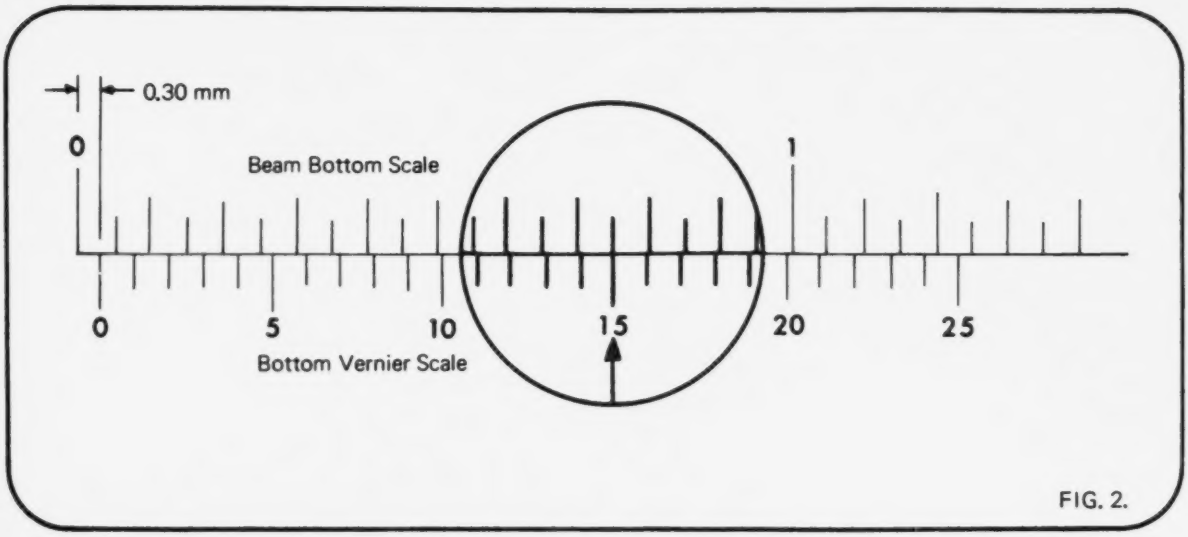


FIG. 2.

How to read the vernier caliper gauge (metric)
The vernier scale on the caliper gauge is part of the sliding jaw, while the top scale is inscribed on the beam which is solid with the fixed jaw. When the jaws are closed the reading is zero and to read a dimension when the jaws are at any setting the procedure is:

FIG. 1.
1. To the left of the 0 on the bottom vernier scale the reading is 30.50

2. The 14 mark on the vernier scale is exactly level with a mark on the beam bottom scale.
This represents 14 × 0.02mm (or 0.14 × 2) = 0.28
Total reading 30.78

Hence opening of caliper gauge = amount indicated up to 0 on the vernier scale
+
twice the reading where the marks on the vernier and beam bottom scale are exactly level.

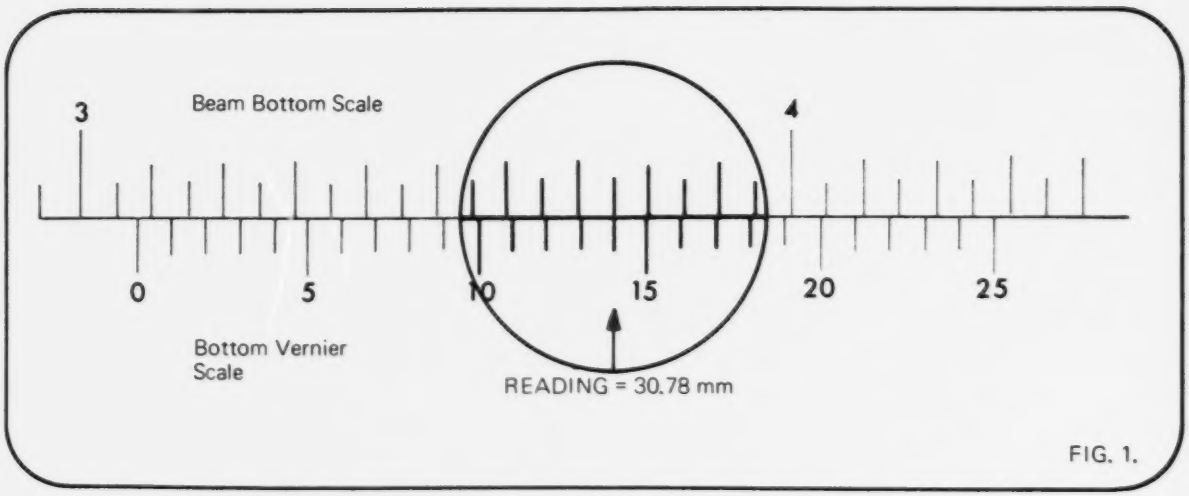


FIG. 1.

The vernier caliper gauge (imperial)
On the beam top scale 1 inch is divided into 10 parts (numbered 1, 2, 3, 4 etc.).
Each of these 10 parts is further divided into 4 parts. (FIG. 1).
Thus each of these divisions has a length of:

¼ of 1/10th = 1/40 = 25/1000 = 0.025 inch

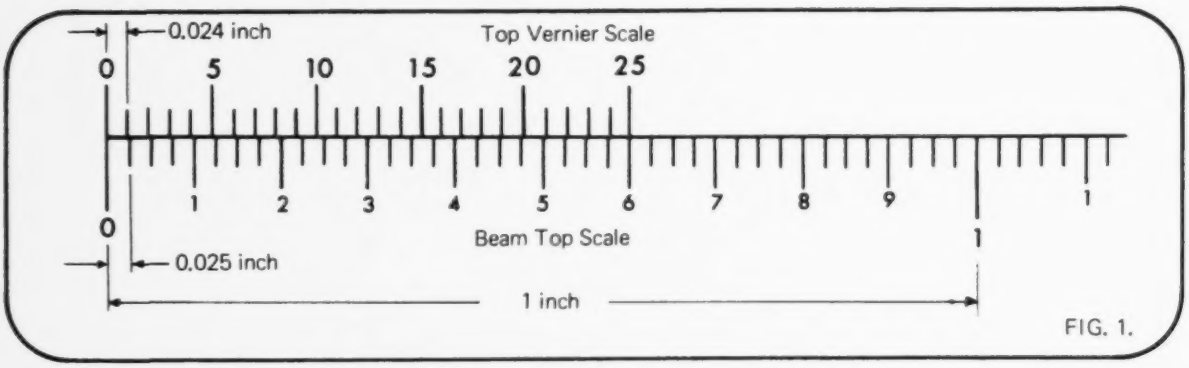


FIG. 1.

On the top vernier scale, (6/10 inch is divided into 25 parts. (FIG. 1).
Each of these has a length of:

1/25 of 6/10 = 6/250 = 24/1000 = 0.024 inch.

Thus the difference in length between one small division on the beam top scale and one on the top vernier is
0.025 — 0.024 = 0.001 inch.

Example:
If the two zero marks are level and the top vernier is then moved until the first small marks are level, the movement is 1/1000 or 0.001 inch; if the vernier is moved until the 20th mark is level with a mark on the beam top scale, the movement is 20/1000 or 0.020 inch. (FIG. 2).

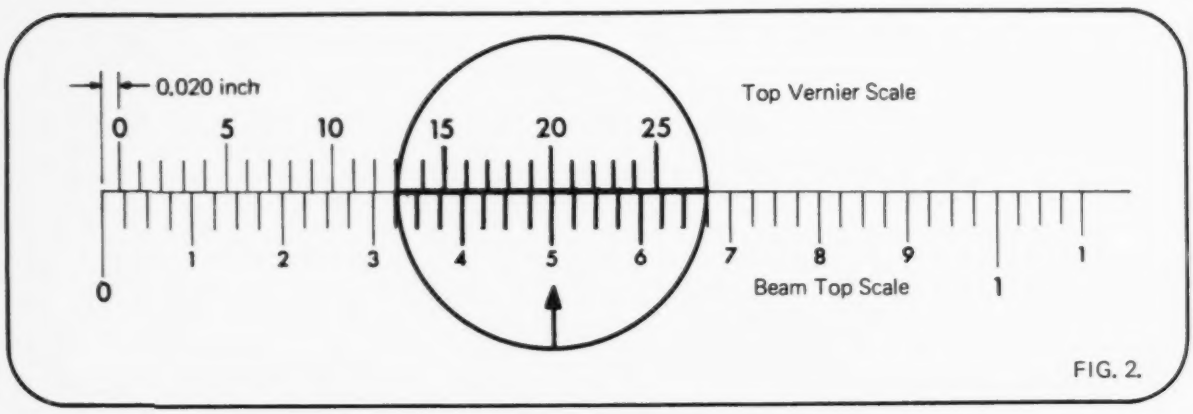


FIG. 2.

How to read the vernier caliper gauge (imperial)
The vernier scale on the caliper gauge is part of the sliding jaw while the top scale is inscribed on a beam which is solid with the fixed jaw. When the jaws are closed the reading is zero and to read a dimension when the jaws are at any setting the procedure is:

FIG. 1.

1. To the left of the 0 on the top vernier scale the reading is	3.225
2. The 16 mark on the vernier scale is exactly level with a mark on the beam top scale	0.016
Hence total reading is 3.225 + 0.016 =	3.241

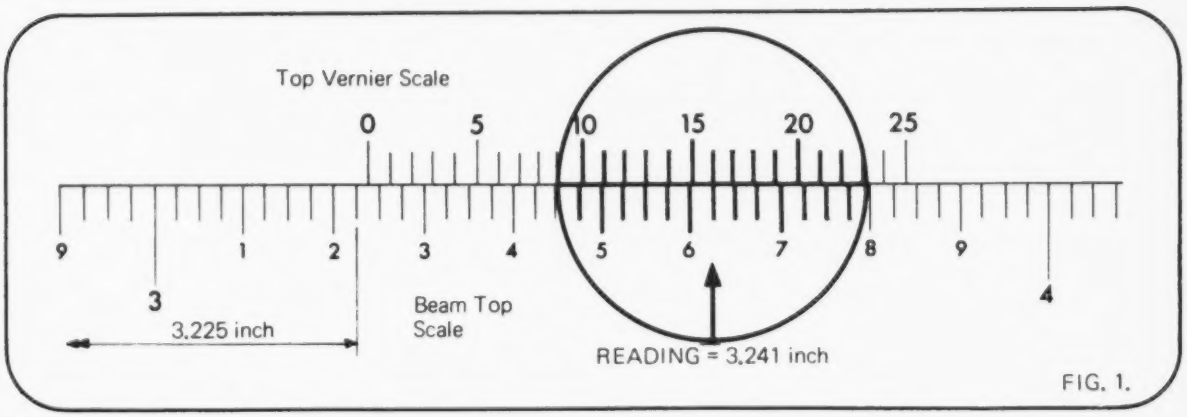


FIG. 1.

FIG. 2.

1. To the left of the 0 on the top vernier scale the reading is	3.075
2. The 11 mark on the vernier scale is exactly level with a mark on the beam top scale	0.011
Total reading is 3.075 + 0.011 =	**3.086**

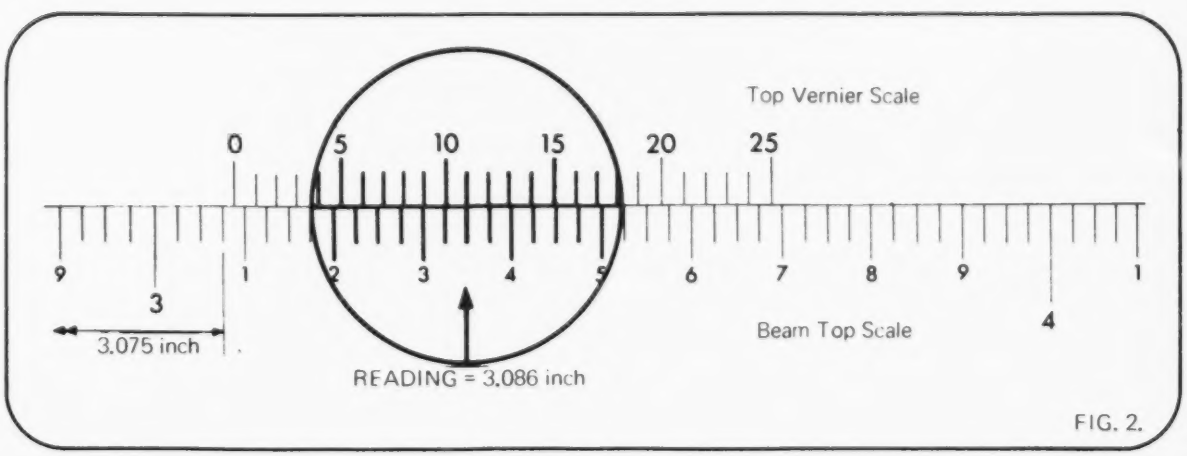
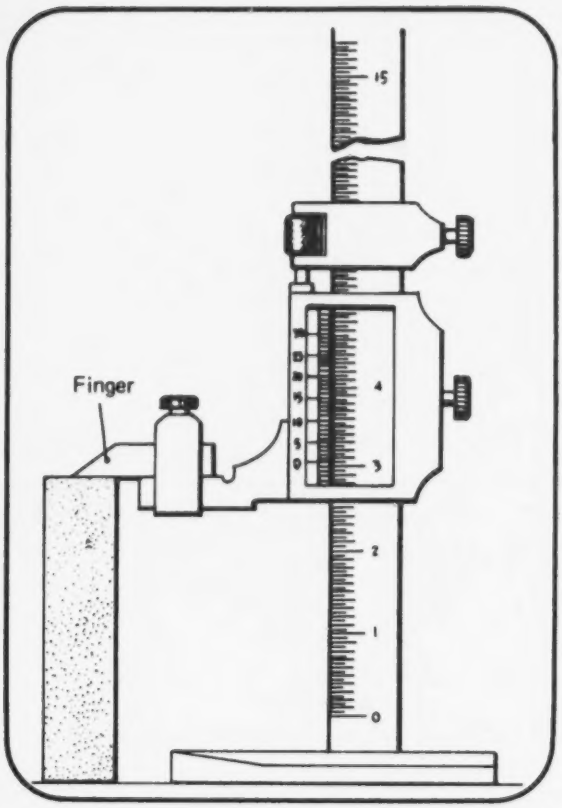
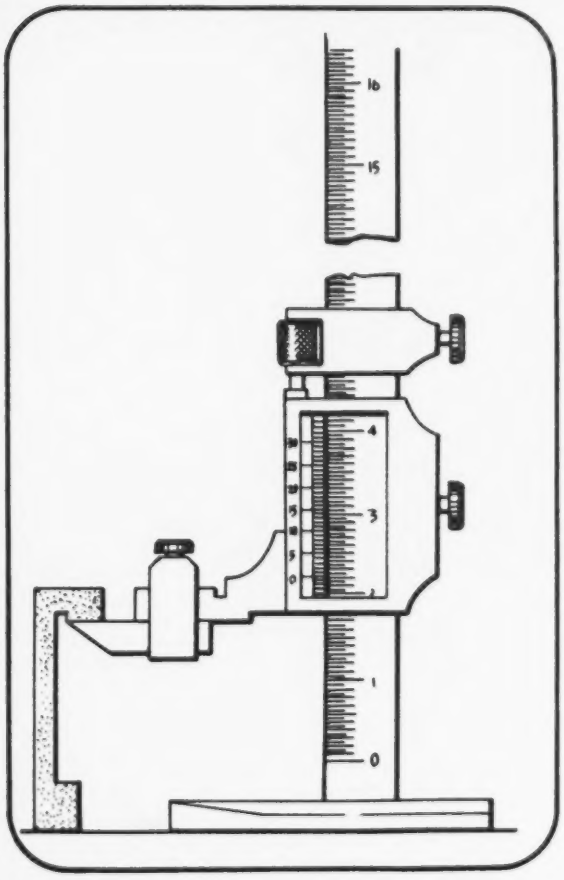


FIG. 2.

Measuring and marking out





Vernier height gauge

This instrument is most frequently used with a scribing attachment or 'finger' which is bolted onto the jaw. The scribing attachment can be used for measuring surface heights, as well as for making precise markings on components; the finger is ground to a sharp edge for marking purposes.

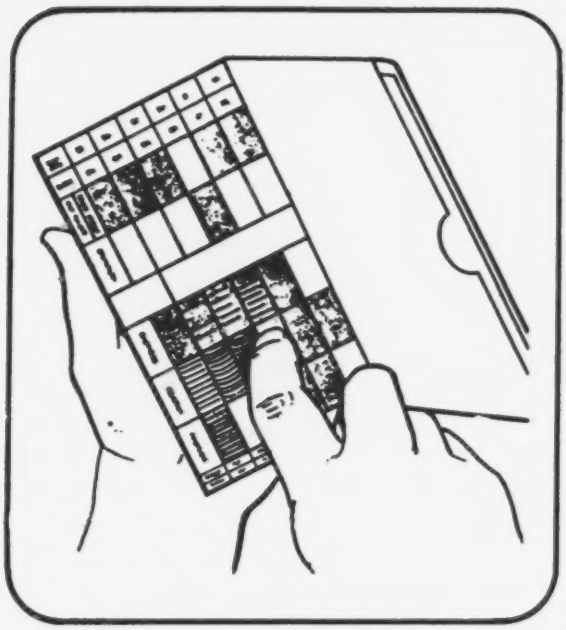
Note:

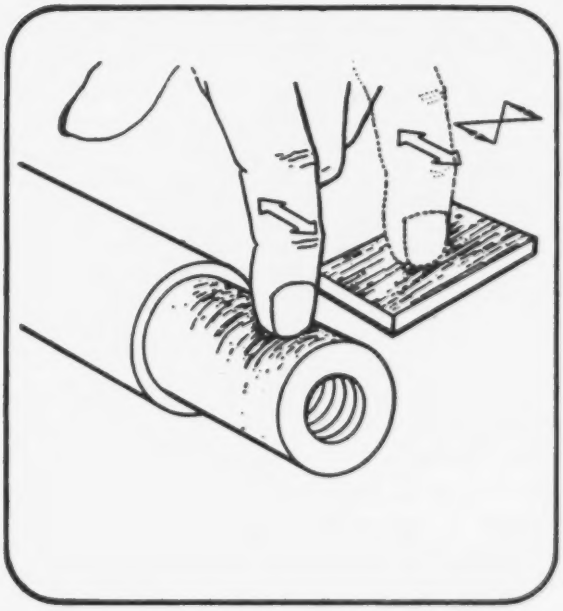
1. It must be remembered that the scale registers height from the working table and that the gauge cannot be relied upon to measure absolute heights from this datum, since the slightest straining or damage to the base can destroy the accuracy of the instrument. For this reason, it is more often used for measuring differences in height.

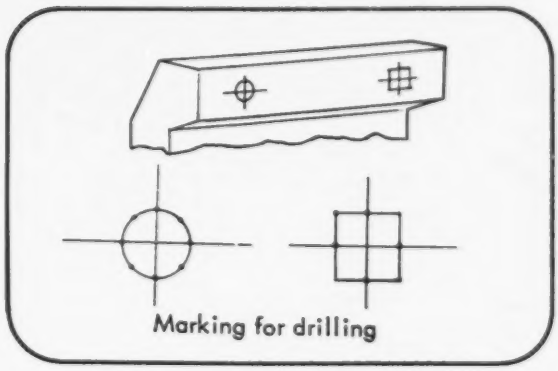
2. It is essential that the base of the height gauge, the surface table and the workpiece be kept perfectly clean at all times to ensure accurate measurement.

3. When not in use the height gauge should be removed from the surface table and returned to stores.

Measuring and marking out







Marking for drilling

Checking surface texture using comparison plates

Comparison plates are a range of metal blocks machined to various calibrated surface textures, with the texture of each one marked in micro-metres. Using these blocks, comparisons can be made visually or by touch, the touch method using a fingernail being the more accurate. With practice the fingernail can achieve high sensitivity which can only be obtained using intricate and expensive equipment.

1. *Visual check*

(a) Select the appropriate comparison plate for texture required.

(b) Thoroughly clean workpiece and comparison plate.

(c) Visually check workpiece and plate alternately.

(d) Check from as many different angles as possible, holding the plate near the workpiece.

(e) Note any surface marks on the workpiece. If, when compared with the plate, they are deeper or more irregular, the texture is not up to standard.

(f) Compare the fineness. If the workpiece is coarser it is not to standard.

Note: The finish of the workpiece should be at least as good as, or preferably better than the appropriate comparison plate.

2. *Check by touch*

(a) Draw the tip of the fingernail lightly over the comparison plate at 90^0 to the "lay".

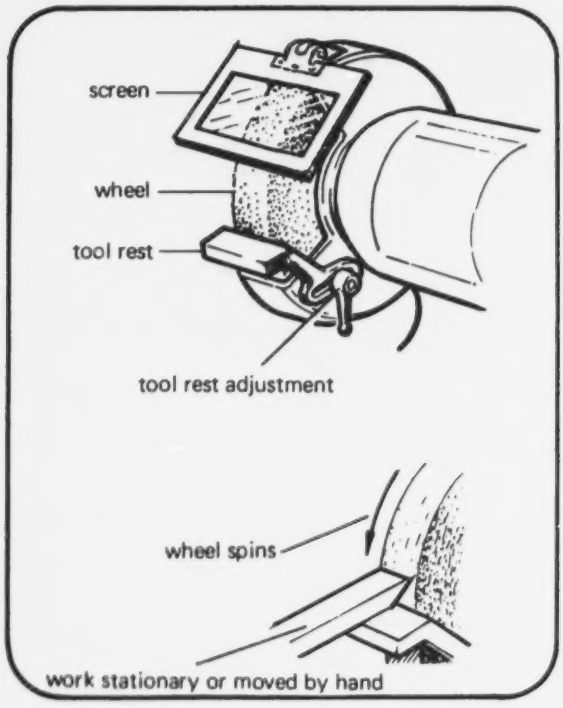
(b) Repeat the operation over the face of workpiece and note difference of "feel".

(c) Alternate between workpiece and comparison plate, noting variation. The workpiece texture should be preferably better than the plate texture.

Marking out for drilling

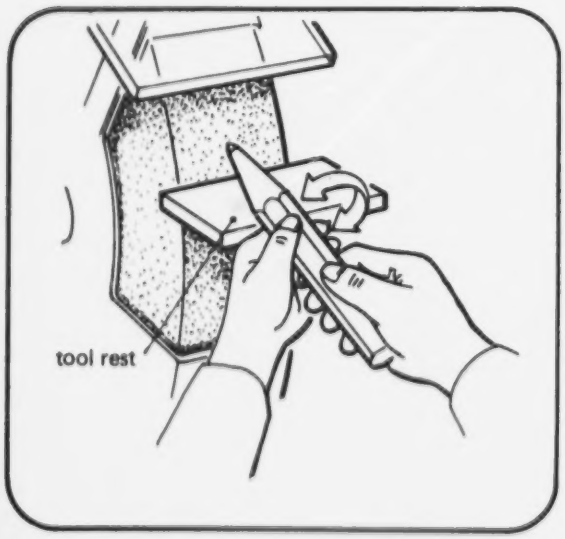
There are two common methods of marking round a planned centre to check the accuracy of drilling when the centre mark has been drilled out. Either a square or a circle is marked with its centre on the intersection already obtained. The side length of the square, or the diameter of the circle, is equal to the diameter of the hole required.

Bench fitting



Abrasive Wheel Regulations (1970)
It is necessary for persons mounting Abrasive Wheels (Grinding Wheels) to have received training in accordance with the Regulations.

If you are in any doubt as to the condition of grinding wheel do not attempt to replace it yourself but consult your instructor.



Off-hand grinder

There are two types:

(a) Bench model or

(b) Pedestal (floor) model

They can be single or double ended, i.e. one or two wheels.

The main parts of the grinder are shown in the illustration.

General information
The off-hand grinder is used for sharpening various types of hand and machine tools. Before commencing any grinding operation carry out the following checks:

(a) Visually inspect the grinding wheel for surface defects before starting the machine.

(b) Check that the grinding wheel is running true and has an even face and sides.

(c) Check that the tool rest is correctly set in relation to the grinding wheel.

Hand grinding of a centre punch

Safety
Safety goggles must be worn.

(a) Hold the centre punch in the fingers of the left hand which should rest on the tool rest.

(b) Hold the head of the centre punch in the tips of the fingers of the right hand. Position tip of centre punch to wheel at an angle of approximately 60°.

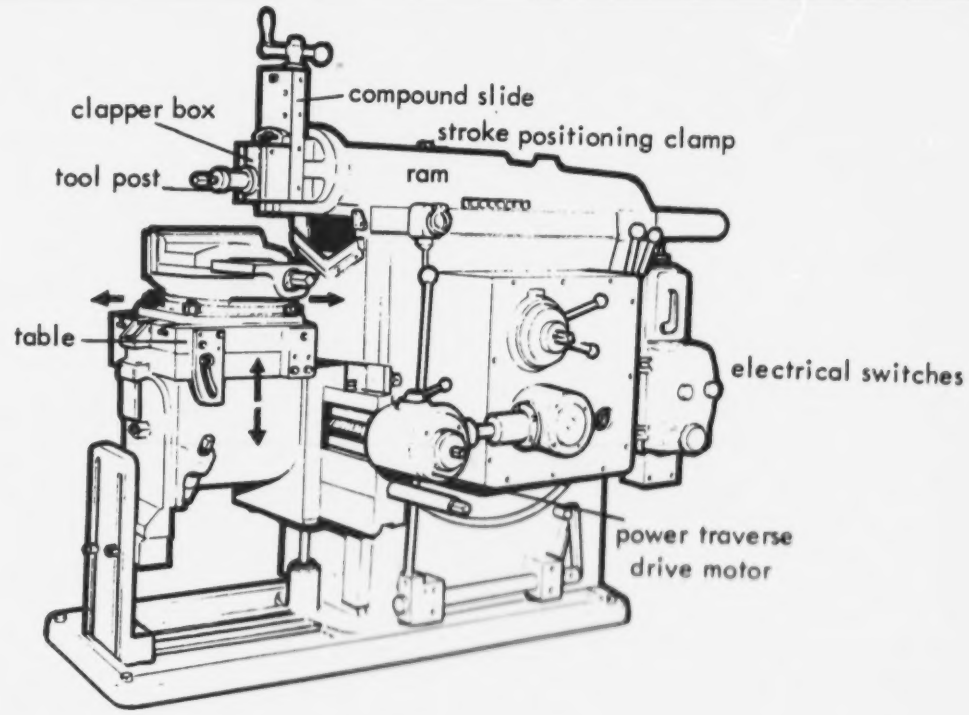
(c) Touch centre punch to front of wheel and rotate by turning the head with the right hand, keeping continuous even pressure against wheel.

Note: Do not allow the point of the centre punch to become overheated as this will cause the point to become soft. Frequently quench the point in a coolant.

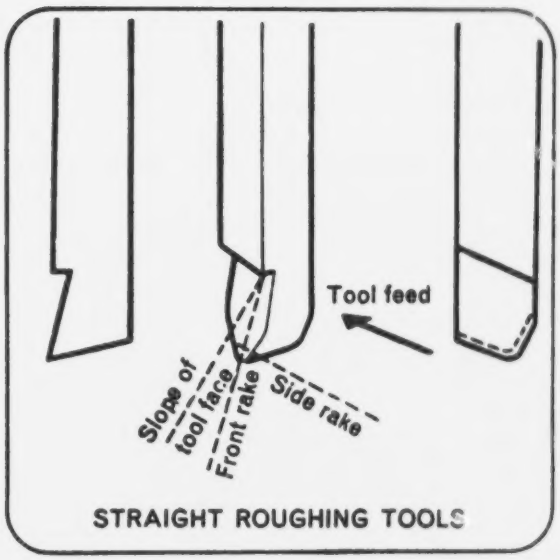
(d) Visually check that the tip is central.

Shaping machine

The shaping machine removes metal by moving a single point tool over a stationary workpiece.



The shaping machine



STRAIGHT ROUGHING TOOLS

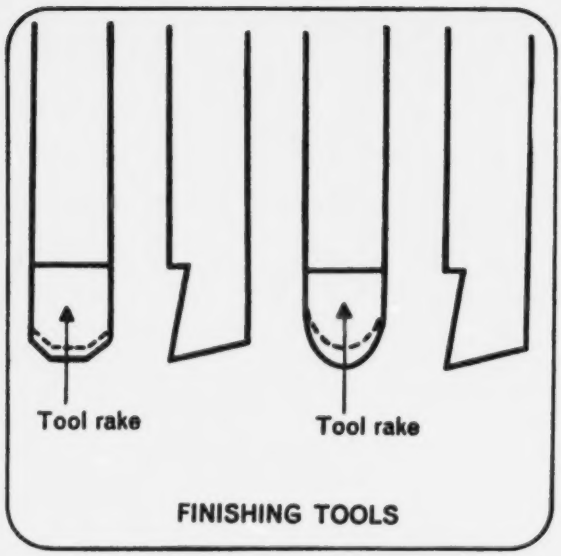
Selecting and mounting the tool

Tool forms and their applications

The general pattern of shaping tools is the same as for turning, except that where possible the shanks should be more robust to withstand the shock at the start of the cutting stroke. The usual movement of the tool across the workpiece when shaping is from left to right, and this requires a side rake sloping from right to left. All tools should be mounted with the smallest possible extension below the clapper box.

Straight roughing tools

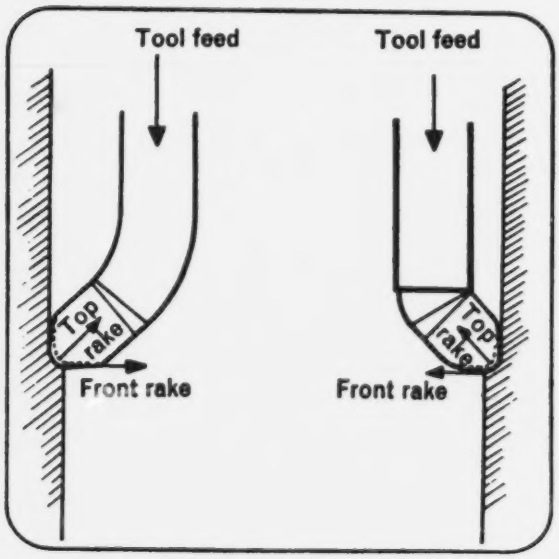
Straight roughing tools are used for general surfacing work to form flat faces on steel, cast iron, brass etc., final cuts being taken with a finishing tool.



FINISHING TOOLS

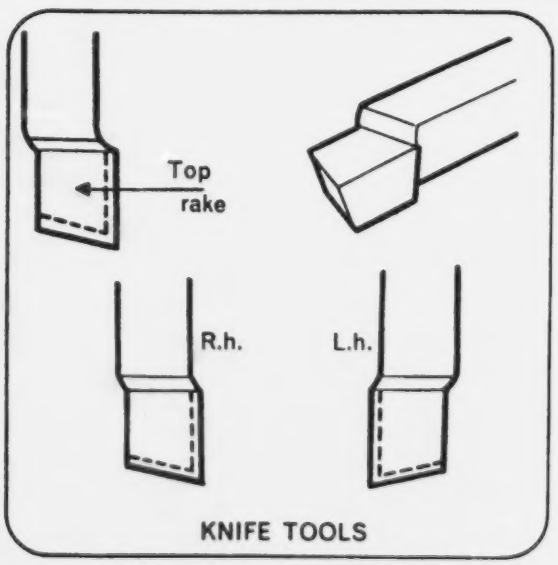
Finishing tools

Finishing tools for general surfacing work are either round or stub nosed. The stub nosed tools are also useful for shaping profiles, radii etc. The tools will cut in either direction as there is no slope on the front rake.



Side tools

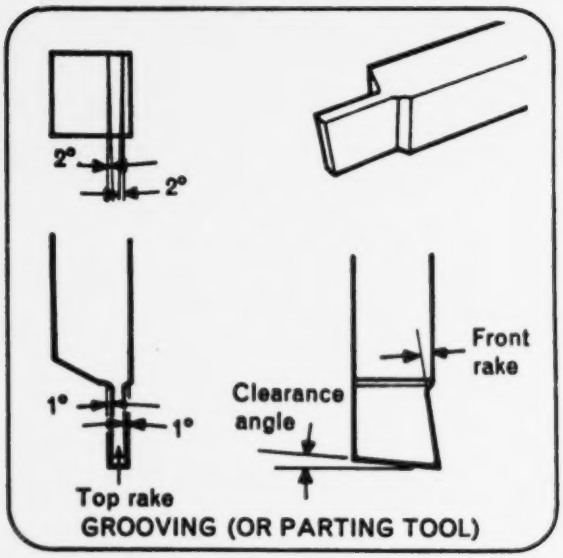
Side tools are used for shaping down vertical or angular faces, also two faces at right angles. Surplus material should first be removed with a straight roughing tool. Side tools are available in both right and left hand form.



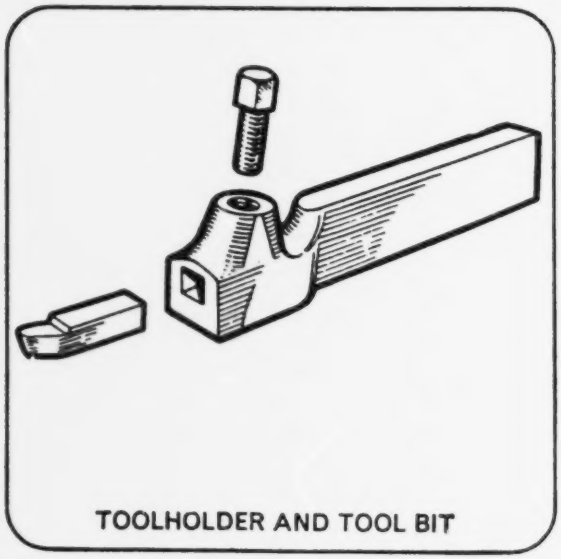
KNIFE TOOLS

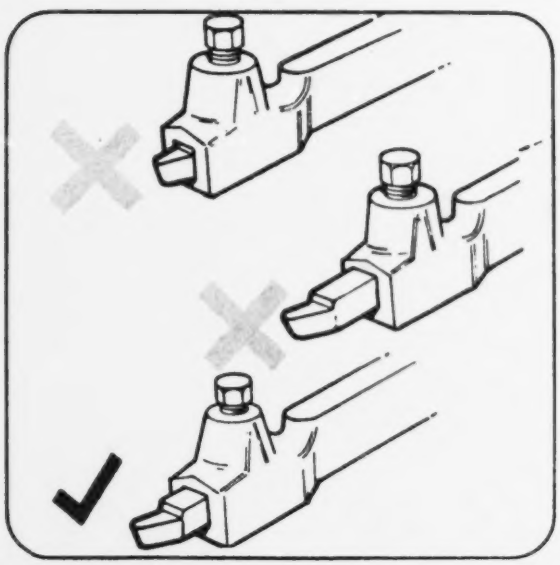
Knife tools

Knife tools are used for finish machining steps, opening out slots etc. They are available for right and left hand cutting. The tool is fed vertically down the face to be machined.



GROOVING (OR PARTING TOOL)


TOOLHOLDER AND TOOL BIT



Grooving (parting) tools

Grooving tools are mainly employed for cutting keyways, slots etc. When cutting broad grooves or slots, one side at a time is machined. Tool angles should be carefully checked, for if the cutting angle is too great the tool may tend to bite into the workpiece.

Toolholders and toolbits

Toolholders which have high speed steel toolbits inserted and secured by a small bolt are used mainly for general surfacing work. Care should be exercised in setting the bit in the holder. If the bit protrudes too far out of the holder it is liable to snap off when cutting commences.

Tool rake and clearance angle table

The following rake and clearance angles apply to most shaping tools:

Material	Front rake angle	Clearance angle
Cast iron, brittle brass etc.	$2^{o} - 10^{o}$	8^{o}
Steel	$10^{o} - 20^{o}$	10^{o}
Light Metals	$15^{o} - 30^{o}$	12^{o}

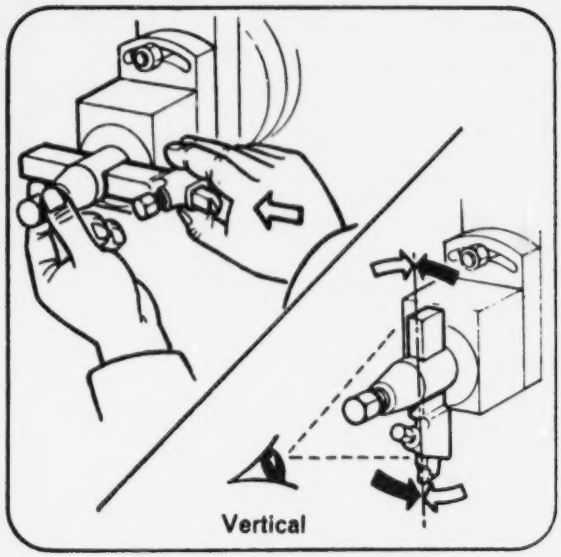
It should be noted that the amount of clearance should not be more than is necessary to allow the tool to cut cleanly. If more than necessary is allowed the tool point is made sharper and this removes the "body" from the tool which would otherwise assist it to survive and conduct away the heat generated when cutting.

Mounting and setting toolbits and toolholders

1. Secure toolbit in toolholder

(a) Insert the toolbit in the square hole in the toolholder allowing a minimum length of the square section to overhang the holder.

(b) Finger tighten the clamping screw ensuring that the front face of the tool is square to the clamping screw.



2. Mount toolholder in toolpost
(a) Turn the toolpost to position the hole at 90° to the head slide.

(b) Loosen the bolt at the end of the toolpost and slide in the toolholder, ensuring the cutting edge of the toolbit is pointing forward.

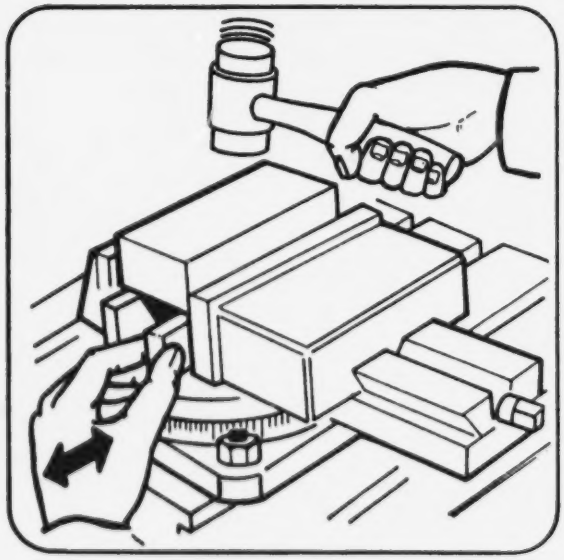
(c) Visually check that the tool is vertical from the front.

(d) Finger tighten the toolpost bolt, and check that there is sufficient length of toolholder protruding to allow the tool to pass over the face of the workpiece without the clapper box fouling the workpiece.

(e) Fully tighten bolt with appropriate spanner.

Note: Solid tools are mounted in the toolpost in the same manner as toolholders.

Safety
Keep fingers well clear of the tool. Always use correct size spanners.



Shaping a Flat Surface

1. Mount workpiece
(a) Select a pair of parallels of sufficient height to hold maximum amount of workpiece without tool fouling the vice jaws at finished size.

(b) Clean vice jaws and bottom face of vice, and de-burr workpiece.

(c) Mount workpiece on parallels, mid-way between end of vice jaws.

(d) Tighten vice, and tap workpiece with a soft hammer, to seat tightly on parallels.

(e) Fully tighten vice, and tap again.

Note: Workpieces in rough state may not seat tightly on parallels.

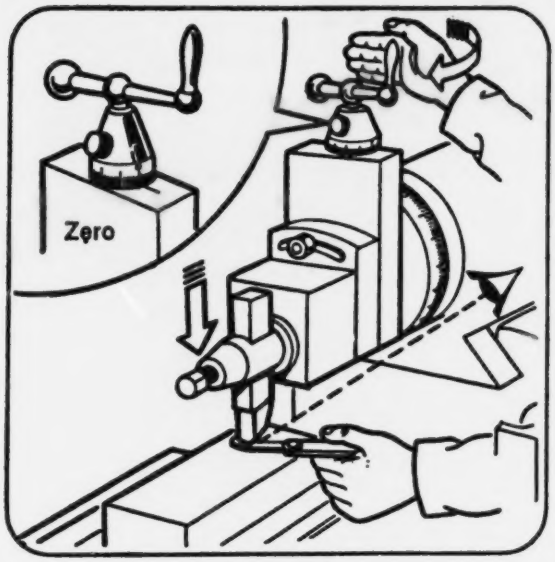
Safety
Ensure the tool is clear of the workpiece when setting and adjusting the traverse.

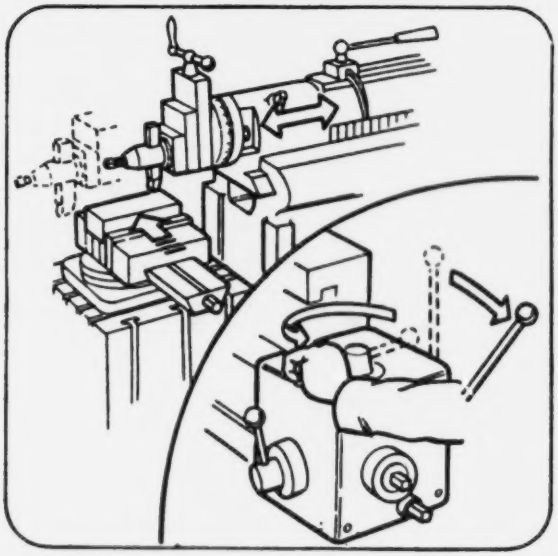
2. Mount tool
(a) Position toolholder over workpiece.

(b) Select suitable tool.

(c) Mount tool in holder, ensuring that tool edge is clear of face of workpiece.

(d) Visually check clearance angles of tool.





3. Set stroke to required length and position.

4. Position tool to workpiece
(a) Wind tool slide down to bring edge of tool to within approximately 1.5mm of workpiece.

(b) Move ram back and forth to visually obtain highest point of workpiece.

(c) Insert a feeler gauge between tool edge and face of workpiece. Wind tool slide down to lightly trap feeler and set index at zero.

(d) Wind ram back to clear tool from workpiece.

(e) Wind tool slide down the required amount for first cut.

Note: Ensure that tool cuts below any scale or rough surfaces of the workpieces.

5. Face workpiece
(a) Start machine and hand-feed cross slide, to bring tool within approximately 1.5mm of side of workpiece.

(b) Select suitable feed, and engage cross feed lever.

(c) Power-feed across face or workpiece.

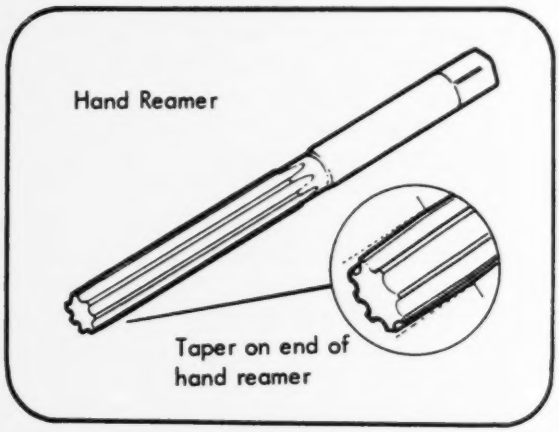
(d) Visually check that swarf is not discoloured (too heavy feed), or chips are not in proportion to cut.

6. Check surface of workpiece
(a) Clean swarf from machined surface, with brush.

(b) Visually check surface finish, and ensure that whole face has cleaned up.

(c) Take a further light cut if required.

Safety
Care of hands. Use a brush to remove swarf. Beware of burrs when handling workpieces.

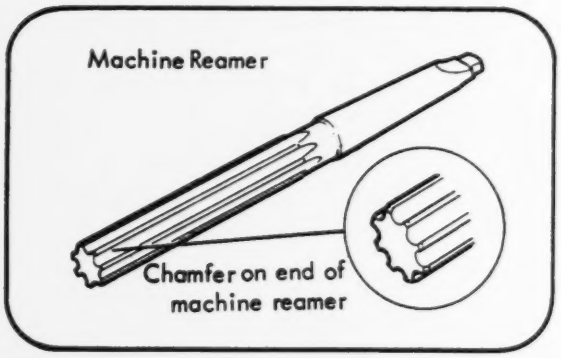


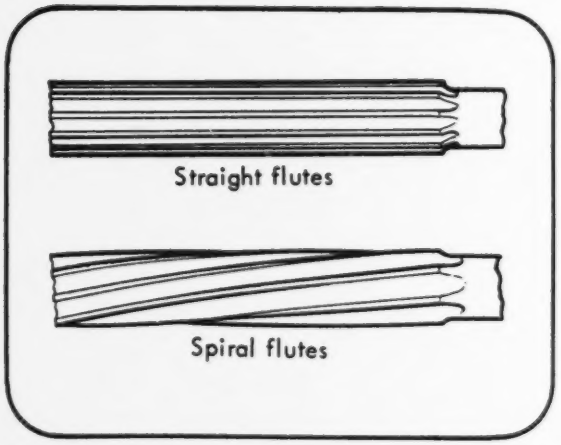
Reamers

Because a drill cannot always produce the correct degree of accuracy and finish, a reamer is used for enlarging and finishing to size, after a hole has been drilled.

Reaming is not used for correcting any mistakes in the position or direction of a drilled hole.

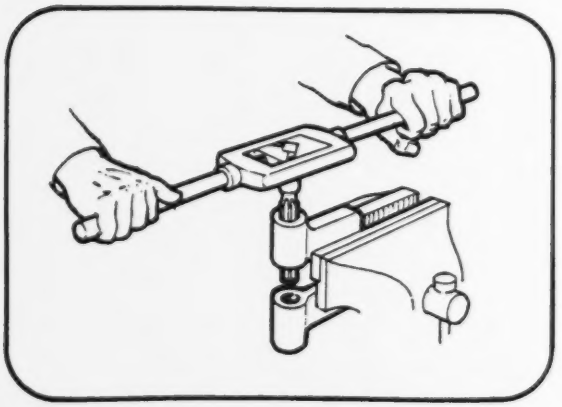
The amount of material left for reaming varies according to the diameter of the reamer, and the material.





With the exception of adjustable reamers, they may be used by hand or in a machine, and may have straight or spiral flutes.

Safety
Do not handle the flutes with bare hands.

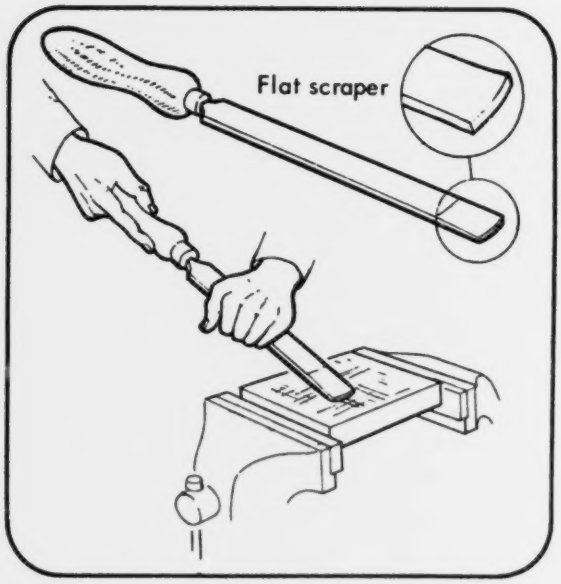


Using reamers by hand

When reaming, the workpiece must be properly supported and rigidly held. A stock (wrench) of appropriate size for the reamer must be used. The reamer must be kept in its correct position relative to the workpiece. The reamer must be run slowly, and excessive feed avoided. The reamer must always be turned in the cutting direction. Ample cutting fluid should be used. When removing the reamer, it must be turned in the cutting direction. Reamers with blunt or chipped edges must not be used.

Scrapers

Scrapers are used to produce a bearing surface from one which has been filed or machined. A scraper consists of a handle and a blade. A scraper should be of high quality tool steel, and the cutting edge should be kept in good condition.

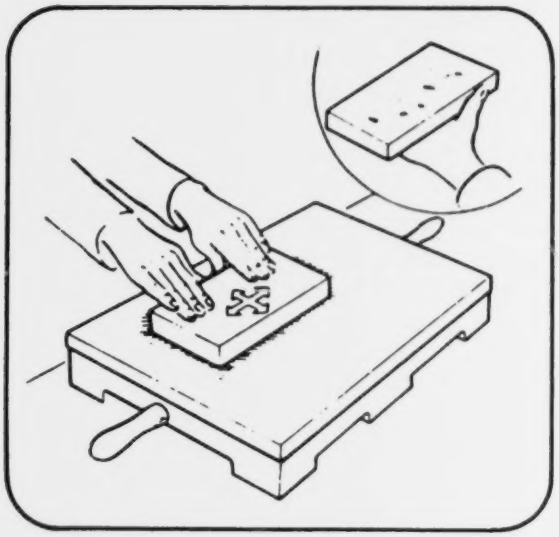


Classification of scrapers

Scrapers are classified by the shape of the blade. There are flat, half-round, and three-square scrapers.

The flat scraper

The flat scraper is used for removing slight irregularities on a flat surface. When the surface has been scraped with strokes in one direction, it must then be scraped with strokes at 90^0 to the first ones.

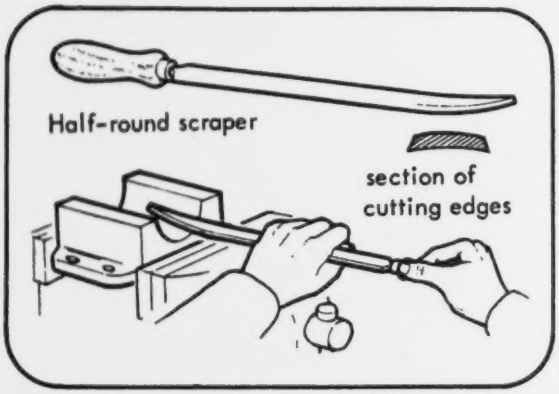


Scraping flat surfaces

(a) Find the highspots on the workpiece by sliding it over a surface plate evenly covered with a thin film of Prussian blue or other suitable marking agent.

(b) Scrape the area showing the greatest amount of high spots.

(c) Check the workpiece frequently against the surface plate, until the required condition has been achieved.

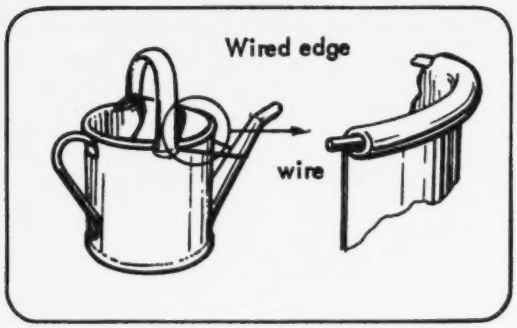


The half-round scraper

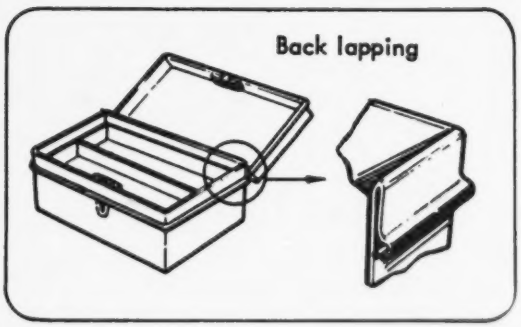
The half-round scraper is used for internal cylindrical surfaces.

Sheet metal work

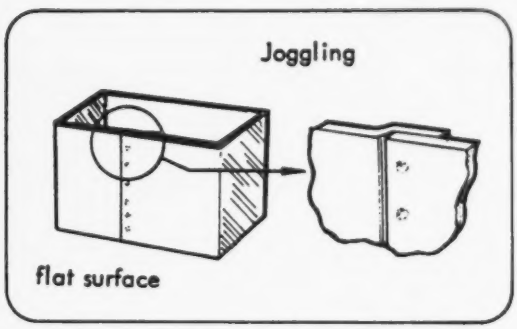
Metal forming processes



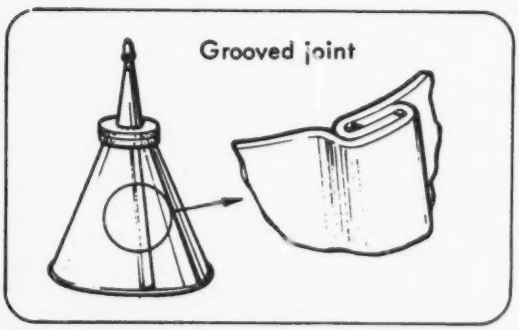
Wiring
A sheet metal fold is formed round thin wire to give an edge with greater strength, and to improve the appearance. Whenever possible edges should be wired before the metal is shaped.



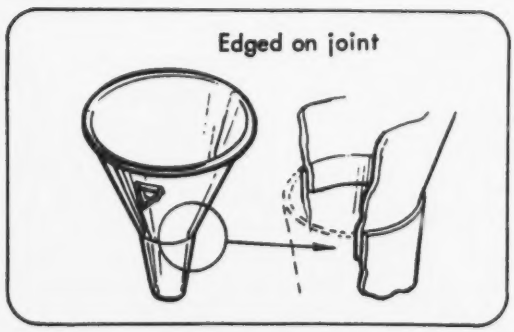
Back lapping
Back lapping is used in making boxes or trunks, where the lid must fit over the sides. The edges are first wired and then the back lap is formed.



Joggling
Joggling is used in preparation for a joint. The edge of one metal sheet is joggled so that the other fits into the joggle, and the two sheets join in one continuous plane.

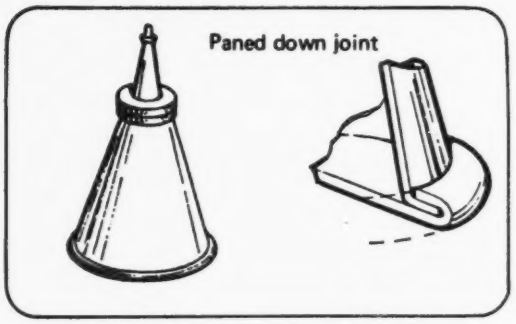


Grooved joint
A grooved joint is used to join two pieces of straight or curved metal of light gauge. There are two stages in the construction of this joint.

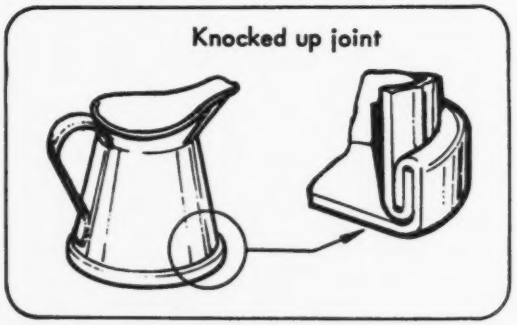


Edged-on joint
This joint is used to fit tops and bottoms to cylindrical shapes. The joint is finally secured by soldering or brazing.

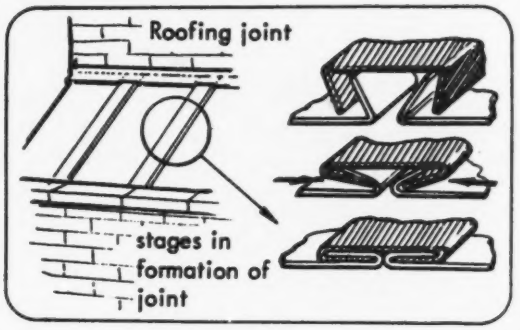
Sheet metal work



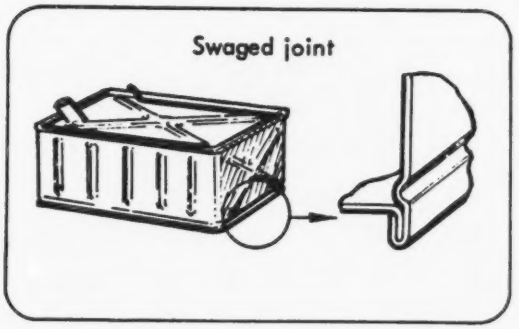
Paned-down joint
This joint fulfils the same function as the edged-on joint, but it is much stronger. It is also secured by soldering or brazing.



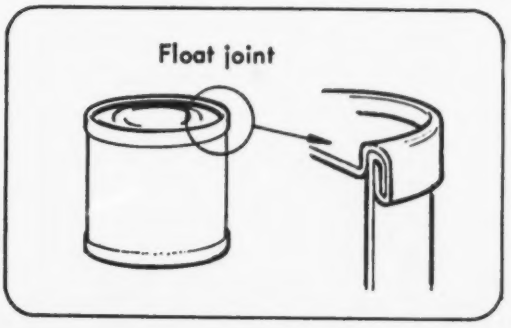
Knocked-up joint
This joint fulfils the same function as the edged-on and paned-down joints, but it is the strongest of the three.



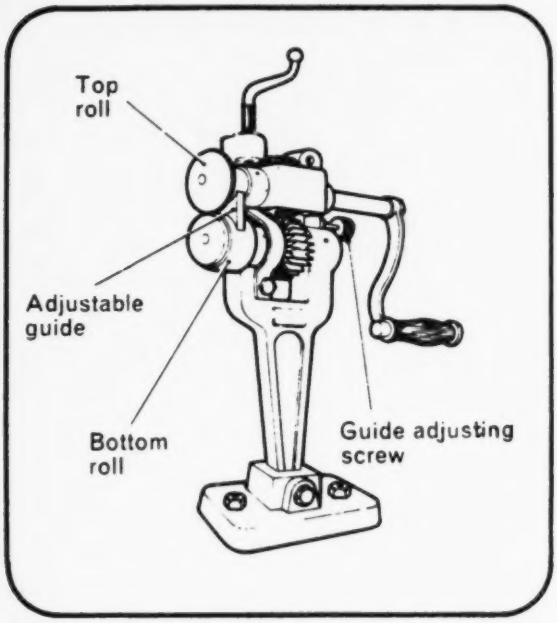
Roofing and panelling joints



Swaged joint
This joint is used in fuel tanks, at the bottom, after the top has been closed.



Float joint
This joint is used as an outside closure on a cylindrical tank, and can be done on a swaging machine.



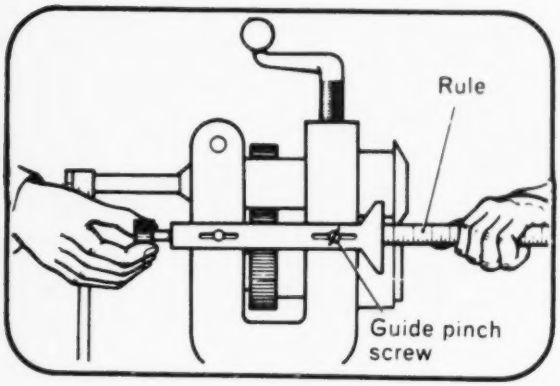
The tinman's jenny

This machine is used for turning edges on discs or forming fairly narrow flanges on cylindrical or conical shaped work. The machine is fitted with two rolls, a fine edged top, or pressure roll adjusted by a hand screw, and a recessed bottom or forming roll. An adjustable guide or gauge is fitted to accurately control the width of required flange.

The jenny is normally fitted to a cast iron bench socket but may also be mounted in a vice.

When mounting, ensure that the machine is firmly fixed or held. Position so that the handle is at the operator's right hand.

Hand-operated jennies are generally limited to materials lighter than 18 SWG. (1.2mm).



Setting a tinman's jenny

(a) Lift top roll slightly

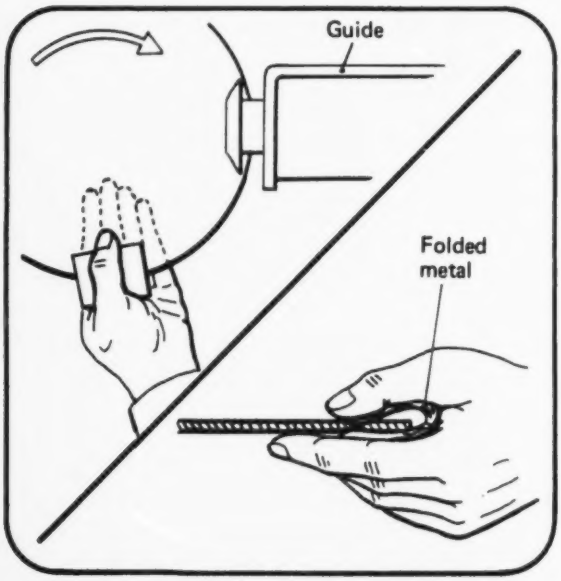
(b) Loosen guide pinch screw.

(c) Set rule against guide and check dimension against top roll.

(d) Adjust guide to required setting.

Tighten pinch screw.

Note: Check size from guide face to inside edge of top roll.



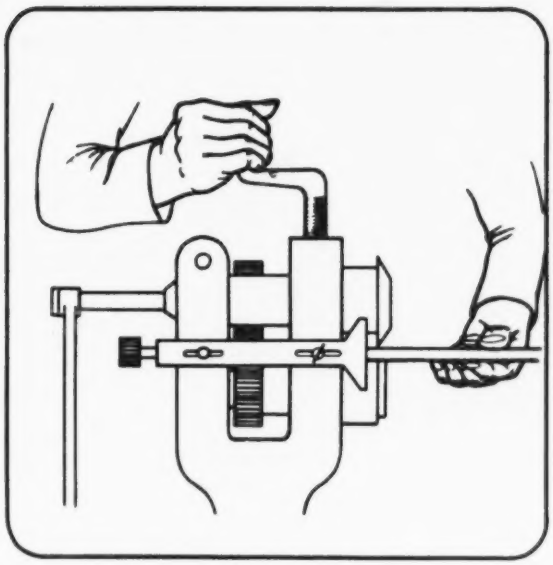
Flanging a disc using a tinman's jenny

(a) Support disc in left hand, thumb on top, fingers supporting underneath.

Light pressure towards centre will maintain disc in contact with guide.

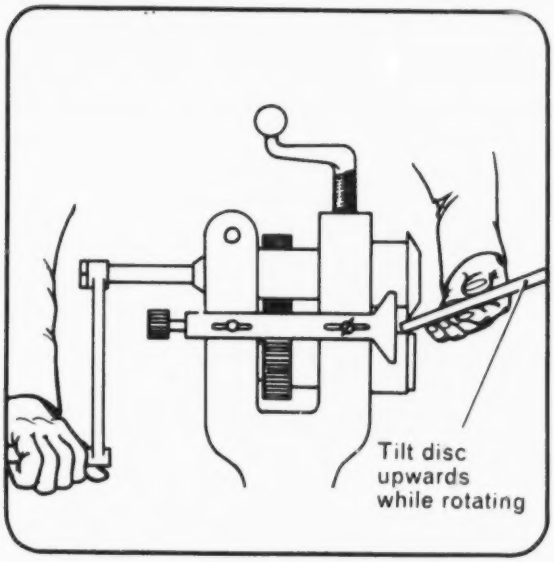
Safety

A small piece of metal folded as shown should be used at all times to prevent injury to operator's hand. The disc should have been previously de-burred by filing or emery to ensure that the edge is smooth.



(b) Position disc between rolls, edge against preset guide.

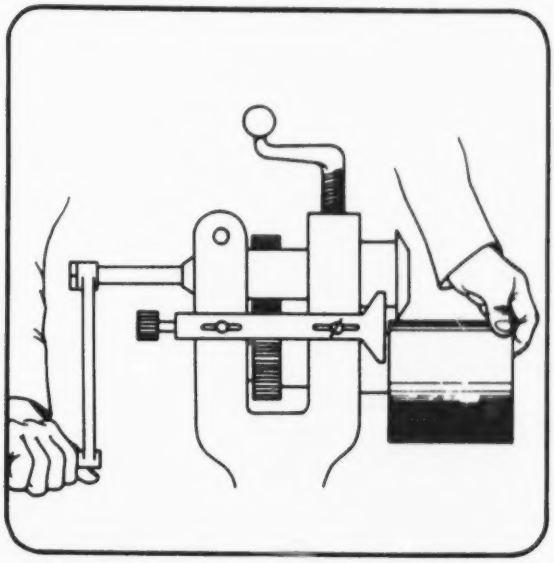
(c) Using top adjusting screw, lower top roll until metal is held firmly between rolls.



(d) Maintaining disc in contact with guide, turn handle clockwise with smooth steady action.

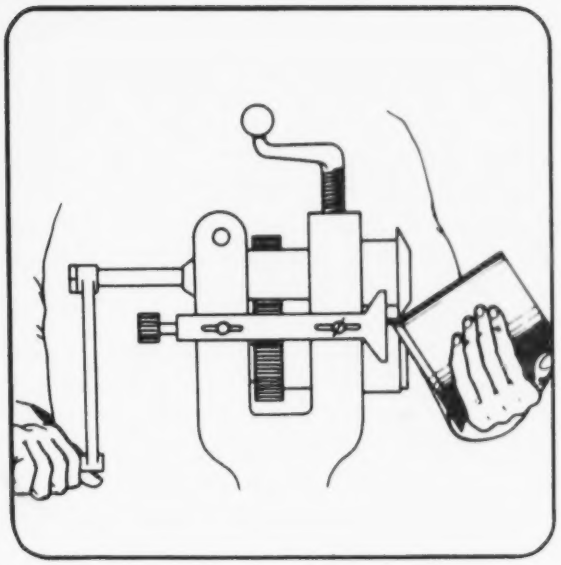
(e) Steadily turning, tilt disc slowly upwards until required angle is obtained.

(f) Loosen top adjusting screw and remove disc.



Flanging a cylinder using a tinman's jenny
Ensure cylinder edge is smooth and free from burrs.

(a) Support cylinder in jenny and adjust top roll.

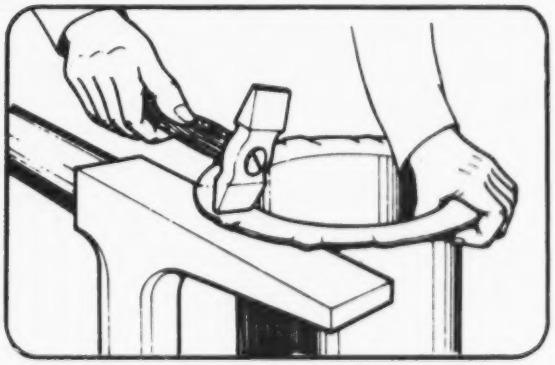


(b) Turn handle slowly and smoothly maintaining cylinder edge in contact with guide.

(c) Tilt cylinder, increasing turning speed smoothly.

(d) Change position of left hand when necessary and continue applying upward pressure until flange is at required angle.

Note: When long cylinders are being flanged, assistance will be necessary. Assistant will raise work to instructions.

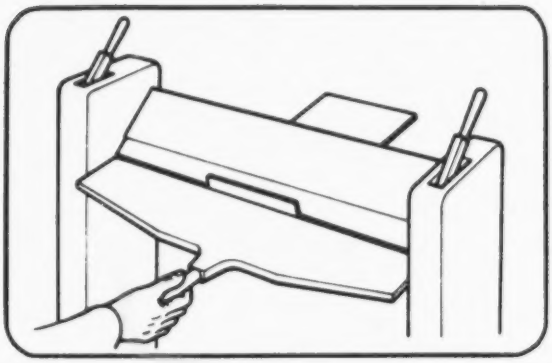


Wide flanges will require additional stretching using a stretching hammer. Work should be supported on a suitable stake.

Sheet metal work

Wiring

Wiring is used to strengthen the edges of light gauge sheet metal articles. It also provides a smooth safe edge and enhances the appearance of the article.



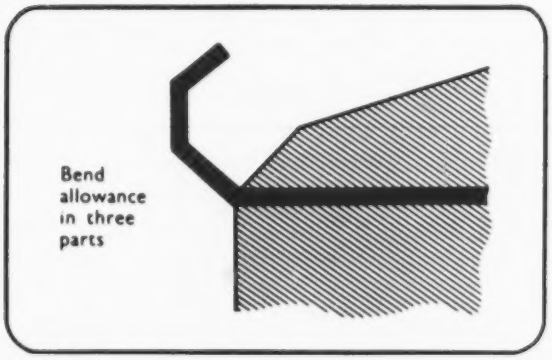
Wiring an edge

Add an allowance of 2 x diameter of wire plus 4 x thickness of metal to any edge requiring a wired finish.

Cylindrical work may be wired before rolling to shape.

(a) Mark wiring allowance into three parts.

(b) Bend allowance as shown, using a bending or folding machine.

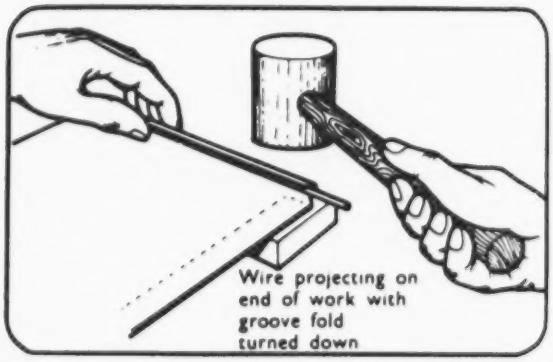


(c) Cut wire to correct length.

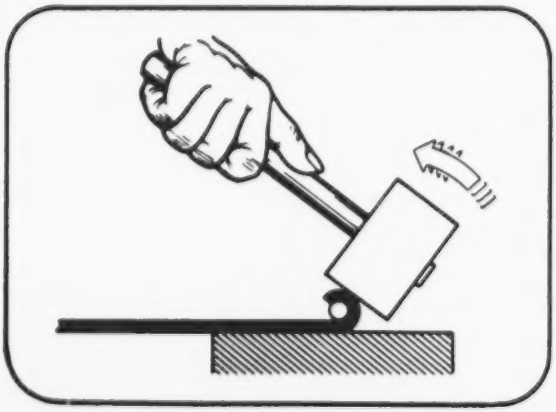
Note: Add thickness of wire to outside diameter of cylinder when calculating length, plus extra for projection past end of work. Make a saw cut through approximately 2/3 of wire diameter at correct length mark.

(d) Place work on bench plate or other flat surface.

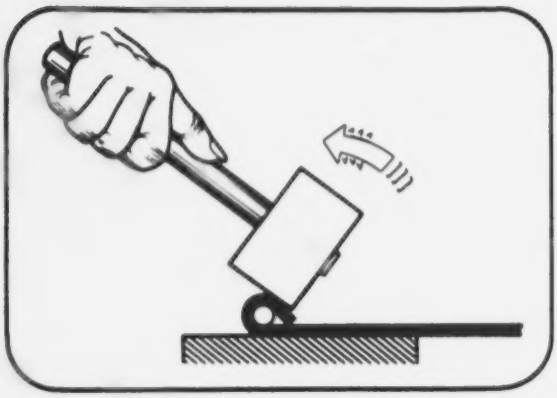
(e) Position wire so that uncut end is projecting beyond edge of work, to ensure that wire joint and seam of cylinder do not coincide.



(f) Examine work to determine if material bent over wire is sufficient to completely cover wire without leaving any gap between edge and surface of wire.

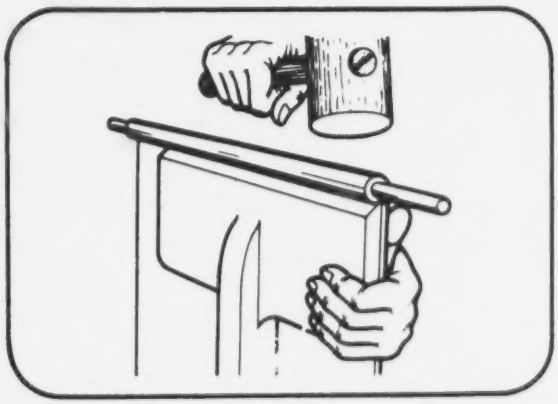


Notes: (i) If insufficient material has been bent over wire, strike edge with a drawing motion as shown, to bring over more material. Failure to do so will result in incomplete coverage of wire and a gap being left between edge and surface of sheet.



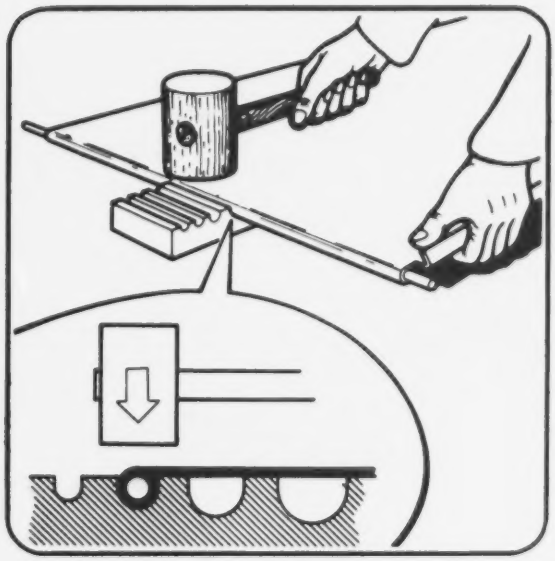
(ii) If excess material has been bent over wire, strike edge with a drawing motion as shown, to reduce amount of material available for complete coverage of wire.

(g) Select hatchet stake and check that it is free from chips or marks. Fit securely, in a bench socket or vice.



(h) Postion work as shown, sheet against face of hatchet stake.

(i) Tap along top edge of work to close or "tuck in" edge of metal to wire.

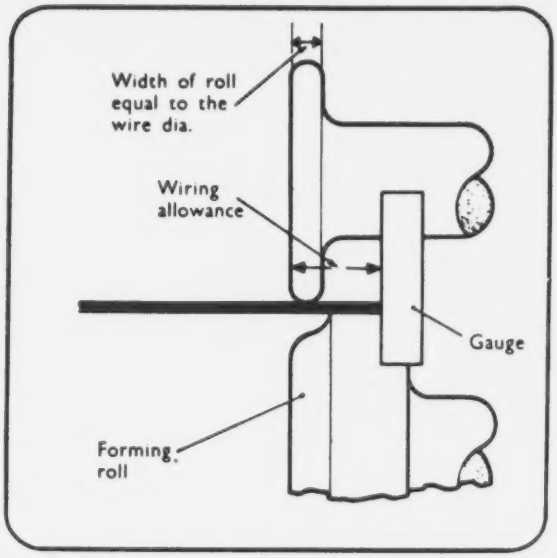


(j) Select and fit a creasing iron after checking that it is free of marks.

(k) Position work, wired edge down into a suitable groove.

(l) Tighten wire by flattening metal above wire with mallet.

(m) Move work along groove, striking directly above creasing iron, until whole length is tightened.



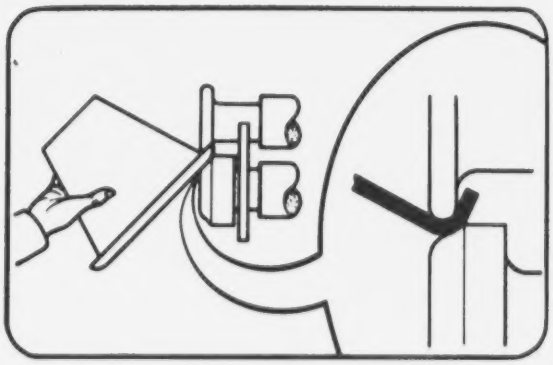
Wiring a curved item

Wiring wheels are similar to jenny wheels but the top roll has a wide rounded edge and the lower roll has a rounded groove. Various widths of top roll are supplied for different diameters of wire.

(a) Select correct top roll.

(b) Fit top and bottom rolls.

(c) Fit strip gauge to arrow for close setting.

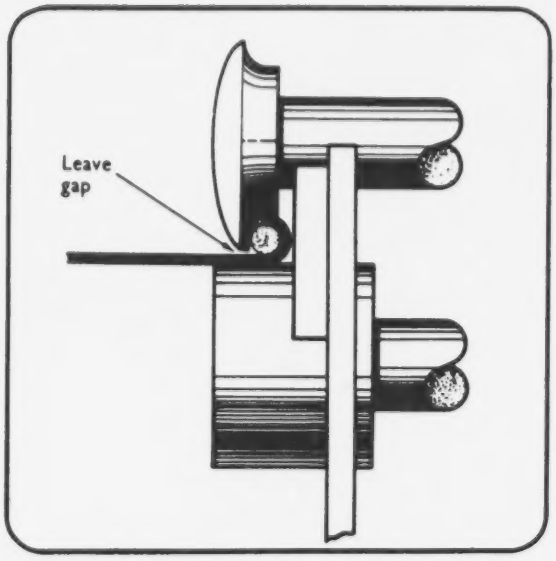


(d) Set gauge to wiring allowance. Measure from outside of top roll.

(e) Support work between wheels and tighten top roll slightly.

(f) Turn handle keeping edge of work in contact with gauge.

(g) Raise work while turning, as for jennying. Tighten top roll slightly as required.



(h) Support on suitable pipe stake or mandrel and insert pre-formed wire.

(i) Close metal over wire, using mallet.

(j) Change forming rolls for closing rolls. Top closing roll has curved inner edge as shown. The lower closing roll supports the work.

(k) Re-adjust gauge, to allow top roll to tuck metal close.

(l) Position work in machine. Adjust top roll to close metal.
Do not close top roll fully, to prevent edge marking metal.

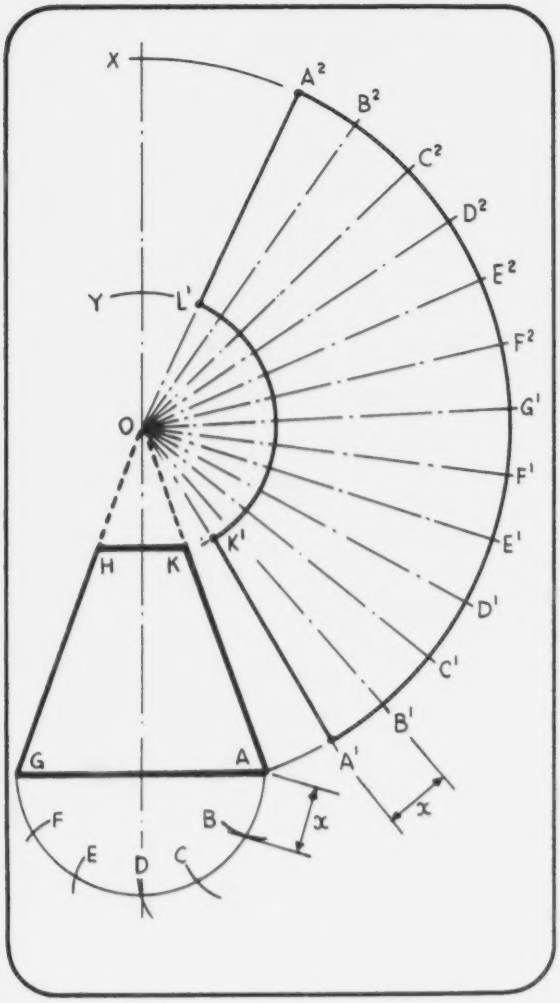
(m) Turn handle, keeping work level, until metal is tucked in all round.

Sheet metal work

Developments

The development of patterns can be achieved by using one of three methods:

(a) Radial Line
(b) Parallel Line
(c) Triangulation



Example of Radial Line Development

The Right Cone

1. Draw elevation AGHK.

2. Produce lines AK & GH to meet at O.

3. Draw arc AG and divide into 6 equal parts A-B-C-D-E-F-G.

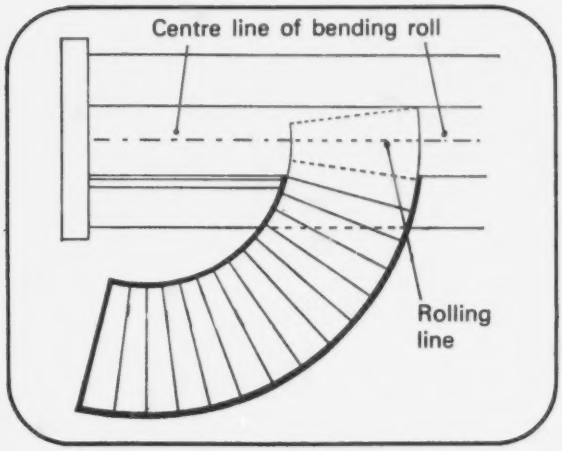
4. With centre at O, draw arcs AX and KY.

5. Take distance x and step off twelve times along arc AX to obtain A^1-B^1-C^1 to C^2-B^2-A^2.

6. Join A^1-B^1-C^1 . . . . . C^2-B^2-A^2 to O.

7. The development required is then A^1-A^2-L^1-K^1.

Note: In the above example no allowance has been made for joining.

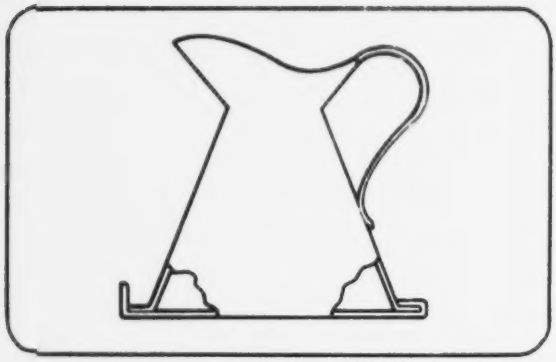


Using bending rolls

The material must be fed into the rolls ensuring that each rolling line in turn coincides with the axis of the top roll.

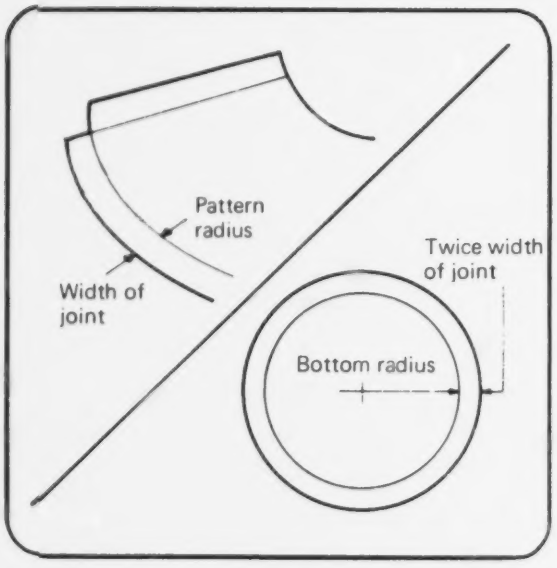
Safety

All power-operated forming and bending machines are dangerous and must never be used without constant supervision by an instructor who has a thorough knowledge and experience of the machine.



Sheet metal work

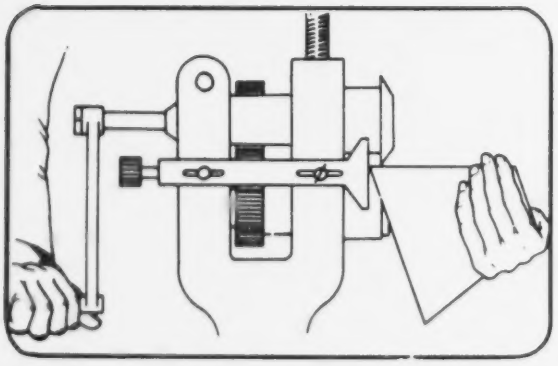
The paned-down joint
The paned-down joint is a simple means of attaching a bottom to an article of cylindrical or conical shape.
Paned-down joints are seldom used on material thicker than 1mm.



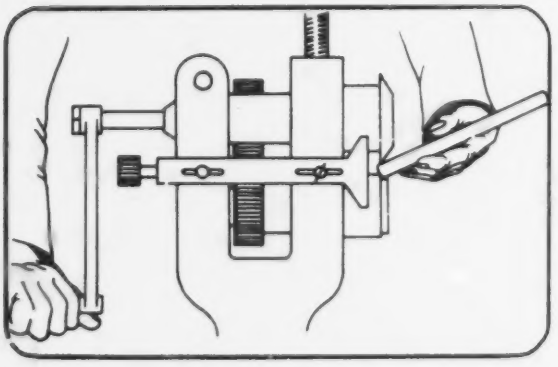
Note: When the patterns are being developed, the following allowances should be made:

(i) Allow width of joint extra to body pattern.

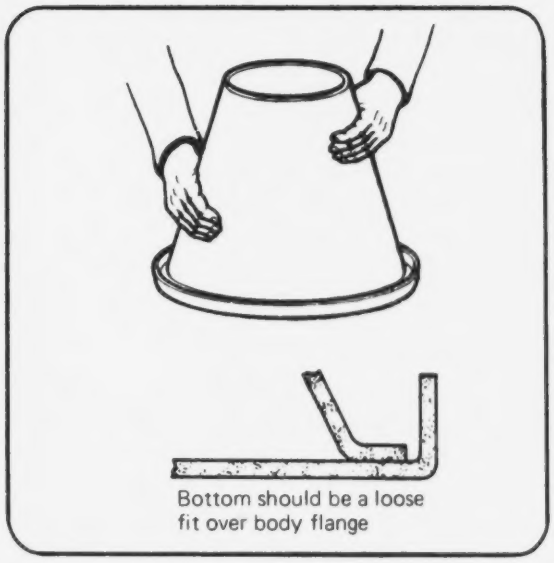
(ii) Allow twice width of joint extra on bottom radius.



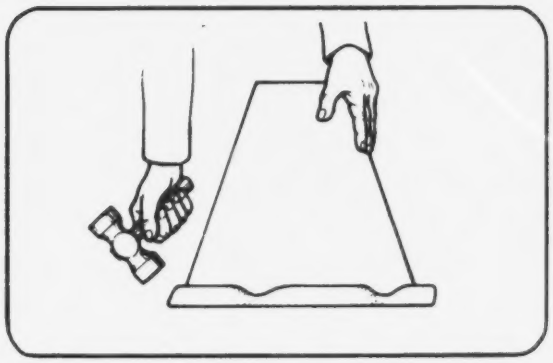
1. Forming a paned-down joint
(a) Using appropriate cutting tools, cut to shape.
(b) Form and seam body.
(c) Set guide on jenny to width of joint. Position body in jenny and form edge.



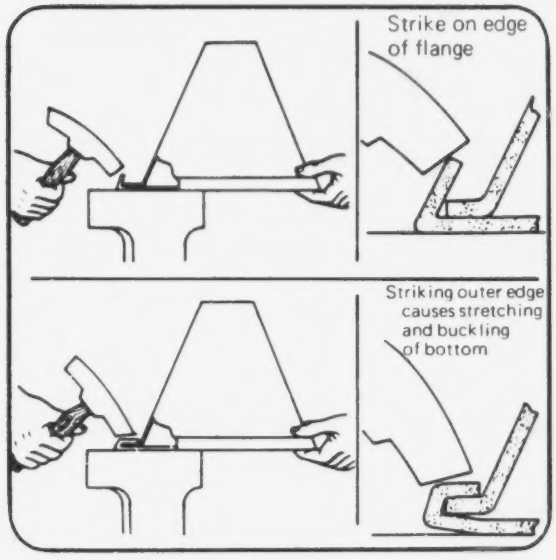
(d) Using same guide setting on jenny, edge up bottom.



(e) Place bottom on bench.
Place body on bottom. Ensure that body is not too tight.



Note: Should body be too large to fit bottom, slight trimming of body edge is permissible.
(f) Using a light hammer, tap bottom edge over slightly at several points. This will retain bottom in position.



(g) Transfer work from bench to suitable working surface. A tinman's anvil is normally used.
Select paning-down hammer.
Check faces are free from blemishes and head is securely fitted to shaft.

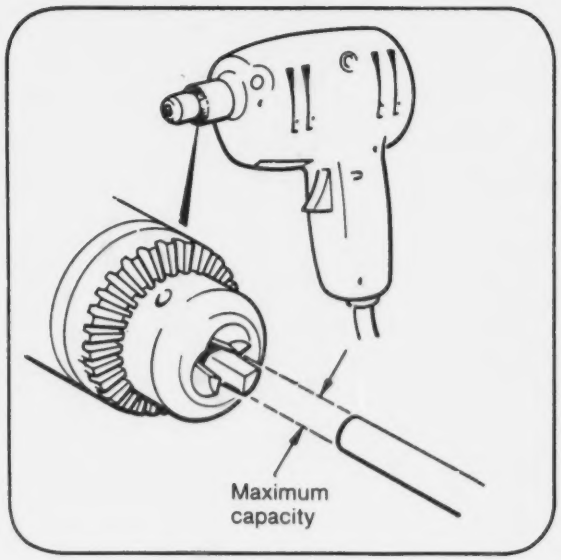
(h) Place work on anvil.
Pane-down flange, ensuring that no deep wrinkles are formed.
Gradual closing will reduce this tendency.

Notes: (i) When turning work, ensure that joint is flat on anvil surface.

(ii) Use squarest face of hammer to start flange.

(i) Change to acute angled face of hammer to close joint.

Note: Exercise extra caution to avoid marking body especially during final stages.



Safe and correct use of portable drilling machines

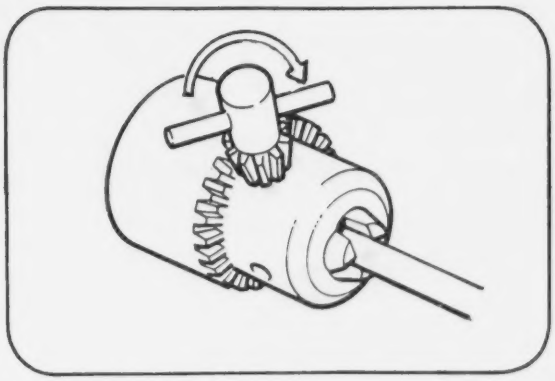
Electric drills are used primarily for drilling but can be adapted to take other tools.

The size of a drill is defined by the chuck capacity.

Some electric drills have two speeds, allowing them use with a wider range of drills, tools and materials.

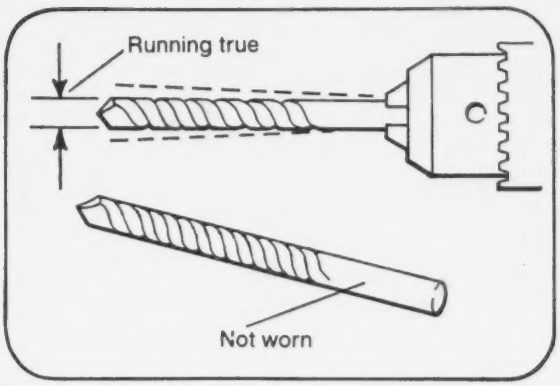
Safety

The shank of a drill should never be reduced to fit a chuck of smaller capacity, as the drill could prove difficult to handle; the tool could slip in the chuck, or the motor could burn out.



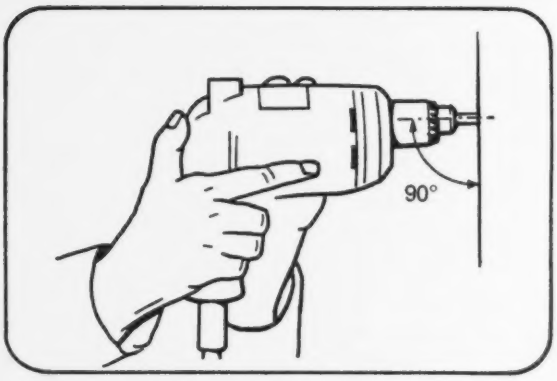
Using a portable drill

1. Place the tool in the chuck and tighten all three of the chuck locking positions with the key. If only one is tightened, the jaws of the chuck can slacken and cause the drill to run out of true or seize in the work.



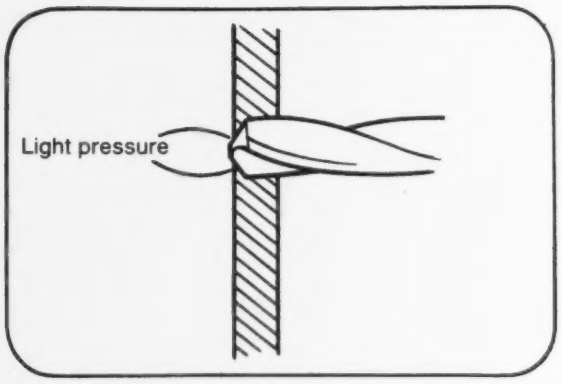
2. Switch on the drill to establish that it is running true, ie:

(a) The bearings are not worn.
(b) The drill is straight.
(c) The shank of the drill is not worn.

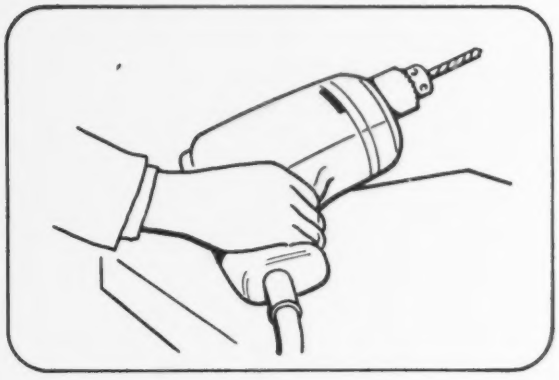


3. Hold the butt of the drill firmly in one hand, and with the forefinger and thumb of the other hand grasp the drill as high up on its body as possible.

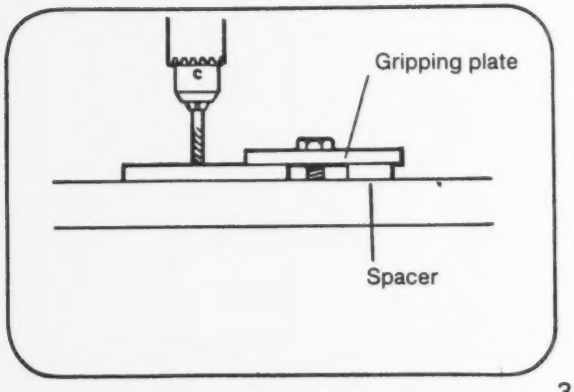
4. Operate the trigger switch with the second finger and make sure that the drill is square to the surface of the work.



5. As the cut deepens towards break-through point, apply a reduced pressure to make sure that the break-through is clean, and that the drill does not stall or pick up the work.



6. Switch off the drill and make sure the drill has stopped revolving before putting it down.



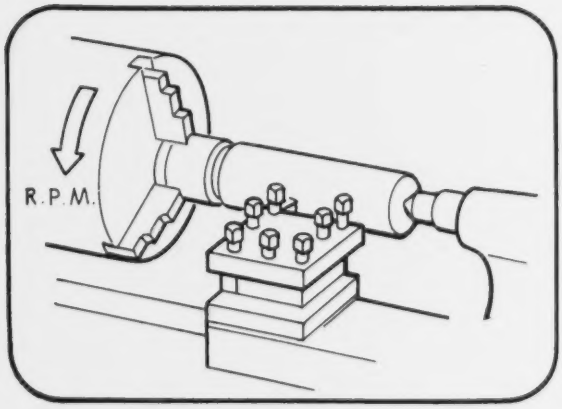
Methods of securing the work to be drilled

Gripping plates

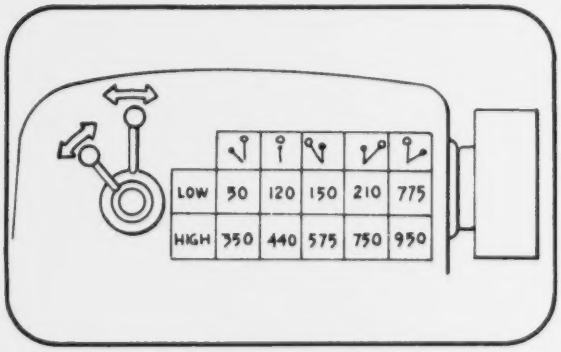
These can be used to secure blocks. The spacer must be the same thickness as the block, and the bolt close to the work for maximum grip.

Turning

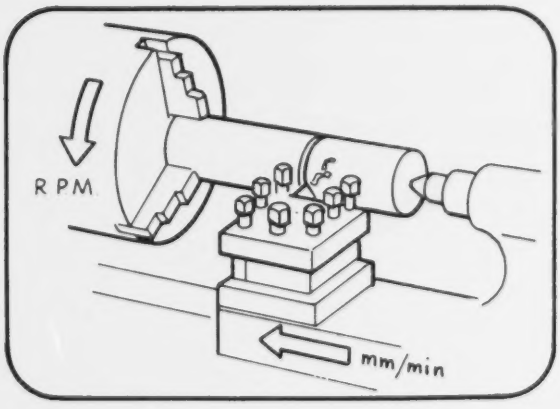
Speeds and feeds To reduce the cost of producing a machined article a maximum amount of material must be removed as quickly as possible by a cutting tool.
This is affected by:
(a) Speed- the rate at which the material moves in relation to the tool point
(b) Feed- the rate at which the tool point is fed into the workpiece.
At this stage of training your instructor will decide the speed at which the machine runs and you will note that the surface finish produced will depend upon the rate at which the machine controls are operated to feed the tool point into the workpiece.



Speed
The spindle speed is the speed at which the chuck, face-plate or fixture revolves and is expressed in revolutions per minute (RPM).



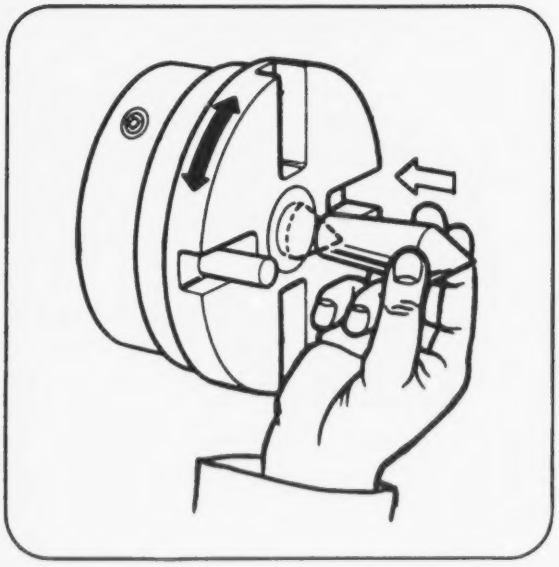
Selecting spindle speeds
The range of spindle speeds available is sometimes shown on a circular scale. The required speed can be selected by revolving the scale until the speed is in line with a pointer.
Spindle speeds may also be displayed on a plaque showing relative positions of two levers to select a speed.



Feed
The feed is the rate at which the tool advances into the workpiece. The movement is expressed in units of millimetres per minute (mm/min) or millimetres per revolution (mm/rev).

The illustration shows an example of feed where a lathe tool is being fed along a rotating workpiece.

Turning



Mounting the workpiece between centres

1. Fit the driving plate to machine spindle.

2. Fit centre into headstock spindle

(a) Clean the taper shank of centre.

(b) Clean the taper in the spindle.

(c) Slide the centre into spindle bore and engage the tapers with a sharp thrust.

(d) Start machine spindle at moderate speed.

(e) Check that point of centre runs true or use machined soft centre.

3. Fit centre in tailstock

(a) Wind spindle in, or out, until approximately 50mm protrudes from the tailstock.

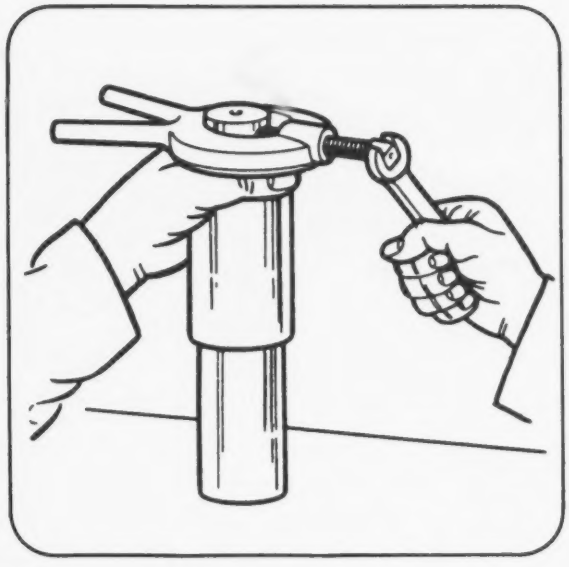
(b) Clean taper in tailstock spindle.

(c) Clean the taper shank of centre.

(d) Slide centre into tailstock and engage the tapers with a sharp thrust.

Note

A workpiece which is to be turned between centres must have holes drilled in its end faces to accommodate the lathe centres. Ends of the workpiece should be faced and then drilled using the correct size of centre drill. (See Training Guide 1B, pages 8 and 11).



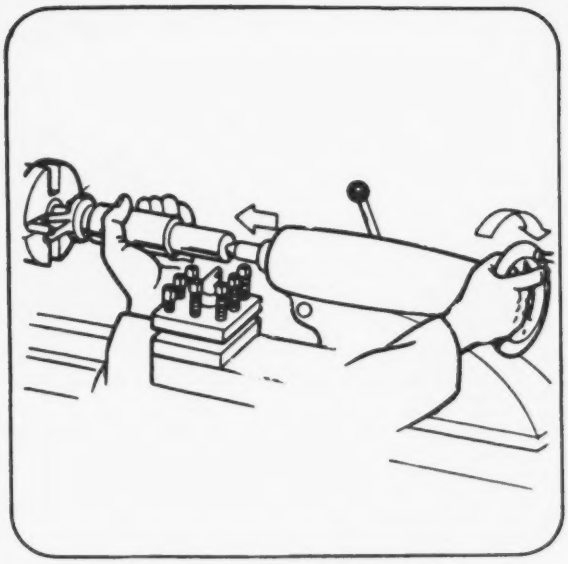
4. Fit the carrier to the workpiece

(a) Select a suitable size carrier for the workpiece.

(b) Hold workpiece vertical, with hand approximately the thickness of the carrier from end.

(c) Slide carrier on workpiece and rest on hand.

(d) Tighten carrier securing bolt.



5. Mount workpiece between the centres
(a) Loosen tailstock clamp.

(b) Slide tailstock to approximate position, visually judging distance between centres to length of workpiece.

(c) Position carrier end of workpiece on headstock centre.

(d) Hold workpiece in position, approximately parallel to machine bed and wind saddle to position tool level to end of workpiece.

(e) Slide tailstock up to saddle and clamp in position.

(f) Apply lubrication to centre.

(g) Align centre hole in workpiece to point of centre and wind centre out to engage in workpiece.

(h) Rotate workpiece back and forth to check that it rotates freely without end play.

(i) Lock the tailstock sleeve.

6. Adjust position of drive pin and carrier
(a) Rotate machine spindle to position drive pin at top.

(b) Rotate workpiece to position tail of carrier up to driving pin.

(c) Loosen drive pin and slide up or down in slot of drive plate to position it within length of carrier tail.

(d) Hold pin in position and tighten firmly.

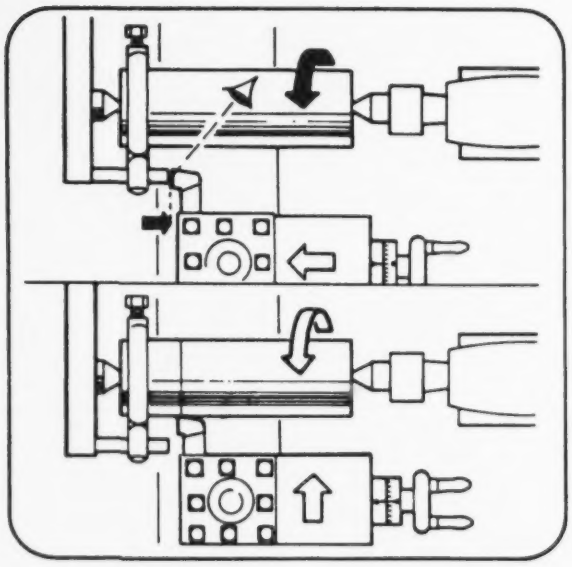
(e) Loosen carrier and slide along workpiece to position tail within length of driving pin.

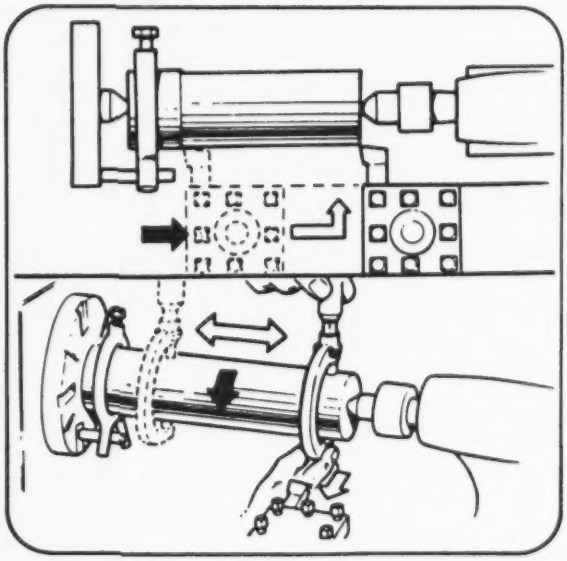
(f) Visually check that carrier securing bolt will fully engage on workpiece.

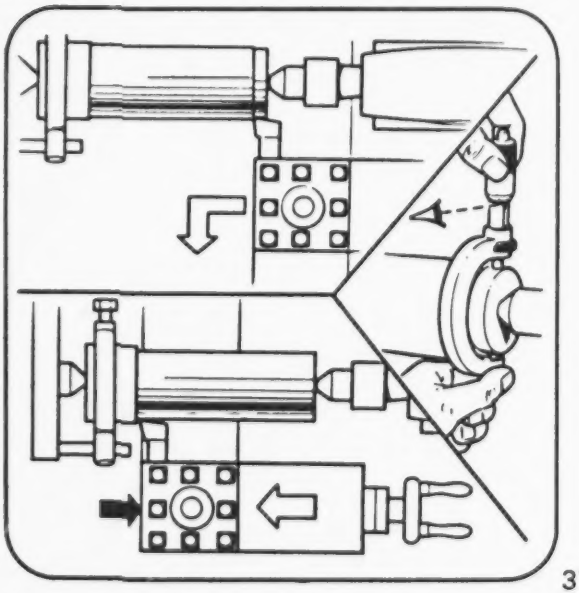
(g) Hold carrier in position and tighten securing bolt firmly.

Note: Protect finished diameters by positioning a piece of soft plate, i.e. copper or aluminium, between the securing bolt and workpiece.

Turning







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Turning a diameter between centres

1. Preparation
(a) Set workpiece between centres.

(b) Set turning tool in toolpost.

(c) Set speed and feed to suit material and surface texture required.

2. Set length of cut
(a) Rotate catch plate by hand.

(b) Wind saddle along to position tool and tool post just clear of carrier and drive pin.

(c) Start spindle and touch tool to diameter to mark length of cut.

(d) Wind tool clear of workpiece.

3. Check parallelism
(a) Touch tool to diameter at tailstock end of workpiece.

(b) Set light cut to clean up diameter.

(c) Traverse cut to marked length.

(d) Stop machine spindle and measure diameter at each end to check parallelism.

(e) Adjust tailstock if taper is found.

(f) Take further light cuts and check until diameter is parallel.

(g) Note size of workpiece.

4. Turn diameter
(a) Calculate amount of metal to be removed.

(b) Rough turn diameter to marked length leaving approximately 0.4mm for finish cut.

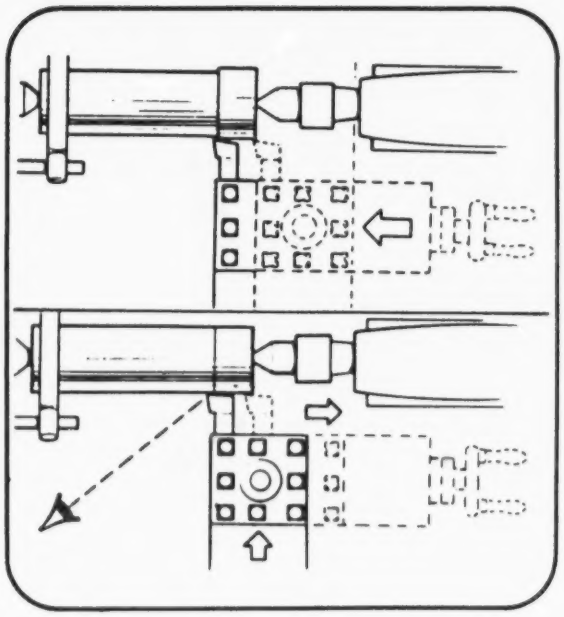
(c) Set for finish cut on cross slide index.

(d) Take cut approximately 3mm along workpiece.

(e) Stop machine spindle and check diameter.

(f) Adjust depth of cut if necessary.

(g) Finish turn diameter.



5. Turn opposite end of workpiece
(a) Reverse workpiece between centres.

Note: Protect finished diameter from damage by carrier with soft packing strip.

(b) Rough turn diameter, allowing tool to just clear shoulder and leaving 0.4mm for finishing cut.

(c) Wind tool in until a very fine gap can be seen between tool point and finished diameter of workpiece.

(d) Traverse cut to just clear end face.

(e) Wind saddle to position tool in front of finished turned diameter.

(f) Wind tool in until no gap can be seen between tool point and workpiece.

Note: Take care not to mark diameter with tool point.

(g) Traverse cut to just clear end face.

(h) Stop machine spindle and check diameter for size.

(i) Blend in joint of cuts.

Note: If diameter is to be finished ground the blending can be omitted.

Turning

Knurling

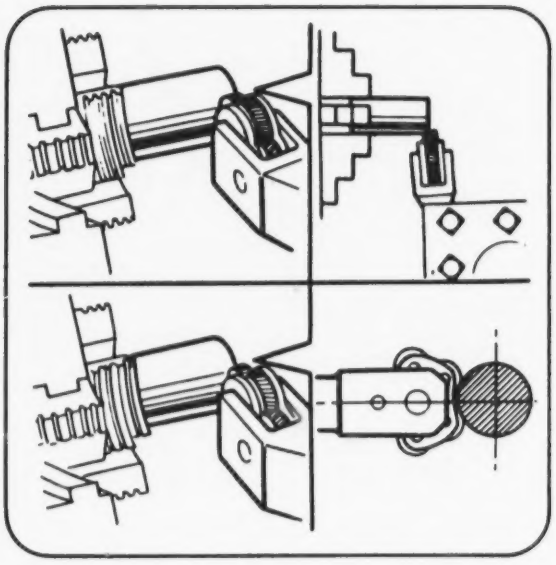
1. Set workpiece

(a) Set workpiece with minimum length protruding from chuck for this operation.

(b) Support long workpieces with a centre.

Note: Setting must be as rigid as possible.

(c) Turn diameter to be knurled approximately 0.3mm below finished size required.



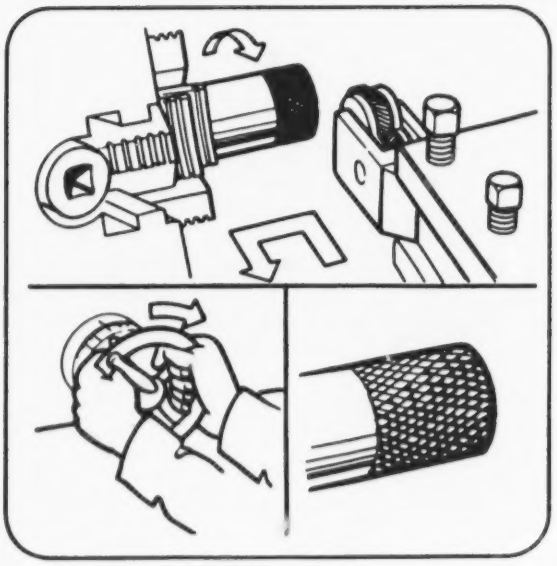
2. Set knurling tool

(a) Visually check that knurling tool is clean of swarf. Clean tool with wire brush if necessary.

(b) Set pivot pin to central height.

(c) Visually set knurling tool at a slight angle to give lead-in.

(d) Tighten tool securely.



3. Knurling workpiece

(a) Set slow speed and fast feed.

(b) Start machine spindle and apply a good flow of coolant to knurls.

(c) Wind knurl into workpiece applying pressure until full pattern is formed.

(d) Engage traverse and feed along until required length of knurling is obtained.

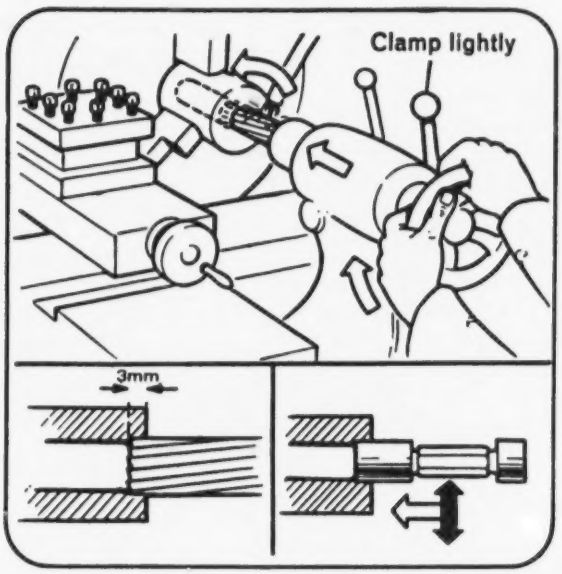
(e) Wind knurl off workpiece with a rapid motion.

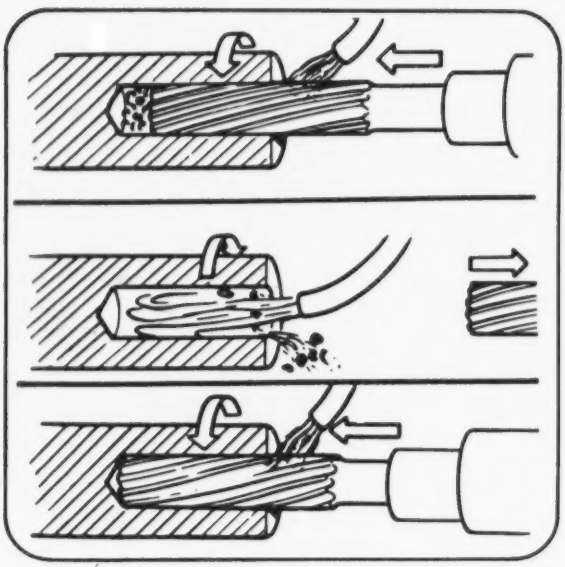
4. Chamfer corners

(a) Remove burrs from end faces by cutting a 45° chamfer to bottom of knurled grooves.

General Note: A reamer will cut slightly bigger if:
(a) The r.p.m. is increased.
(b) The feed is decreased.
(c) No coolant is used.

A reamer will cut slightly smaller if:
(a) The r.p.m. is decreased.
(b) The feed is increased.
(c) Oil instead of coolant is used.





Reaming holes

1. Centre drill.

2. Drill for reaming
(a) Select drill to suit size of reamer and material being reamed.
(b) Drill hole through or to depth as required.
Note: Depth of drilling should be approximately 1.5mm more than finished depth of reamed hole unless the depth is specifically stated on the drawing.

3. Reaming to check size
(a) Set spindle speed about half drilling speed.
(b) Slide tailstock to position end of reamer approximately 3mm clear of workpiece face.
(c) Lightly clamp tailstock.
(d) Start machine spindle.
(e) Apply coolant and feed reamer approximately 3mm into workpiece, maintaining even feed rate.
(f) Withdraw reamer from workpiece.
(g) Stop spindle and check size of bore.

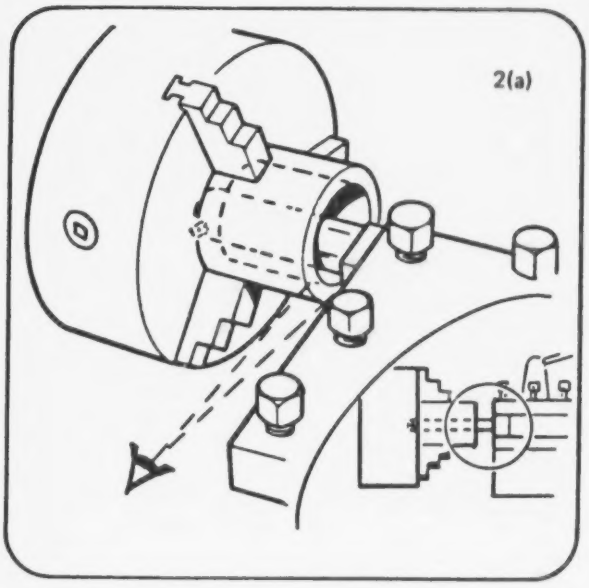
4. Ream to depth
(a) Re-set tailstock to original position and lightly clamp.
(b) Apply coolant and feed reamer into workpiece.
(c) Maintain a light pressure to obtain an even cutting action of reamer.
(d) Wind reamer out of workpiece when resistance to turn of handwheel builds up.
(e) Reverse machine spindle and direct coolant into bore.
Note: This will wash out most of swarf at bottom of bore.
(f) Return spindle to forward rotation.
(g) Wind reamer into workpiece.
(h) Wind reamer out when resistance builds up again at bottom of bore.

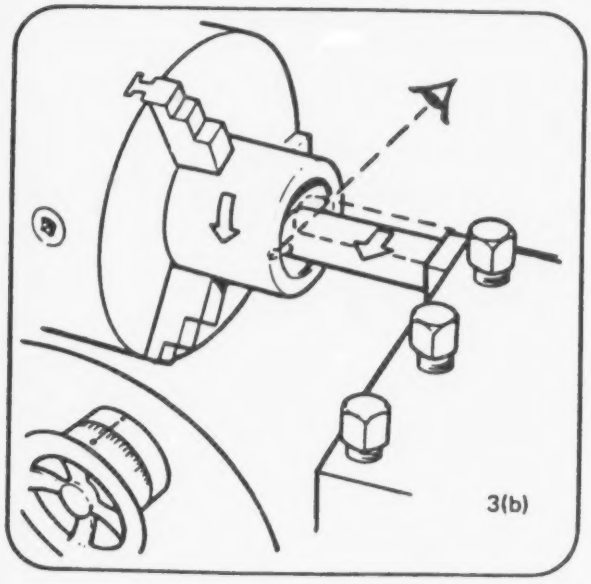
5. Reaming through
The procedure is exactly the same as above except:

Reduce feed rate as pressure eases when reamer is breaking through end of workpiece.

Turning

Boring holes





1. Drill through.
Select drill approximately 1.5mm smaller than finished size.

Note: If very large bore, use maximum size drill available.

2. Set boring tool
(a) Select a boring bar or tool of sufficient length to cover depth of bore, and give approximately 25mm clearance between work face and tool post.

(b) Use stoutest bar possible.

(c) Set tool to position.

3. Touch tool to bore diameter
(a) Position point of tool just within bore.

(b) Wind cross slide out, to touch tool to bore diameter.

(c) Wind saddle so that the tool just clears workpiece face.

(d) Zero cross slide index.

4. Take roughing cuts
(a) Select correct feed and speed.

(b) Determine amount of material to be removed.

(c) Set cut to leave approximately 0.3mm in bore for finish machining.

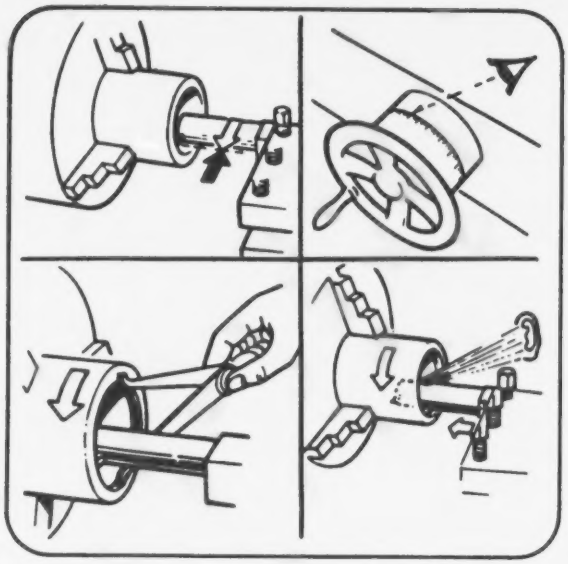
Note: If large amount of metal is to be removed several roughing cuts may need to be taken.

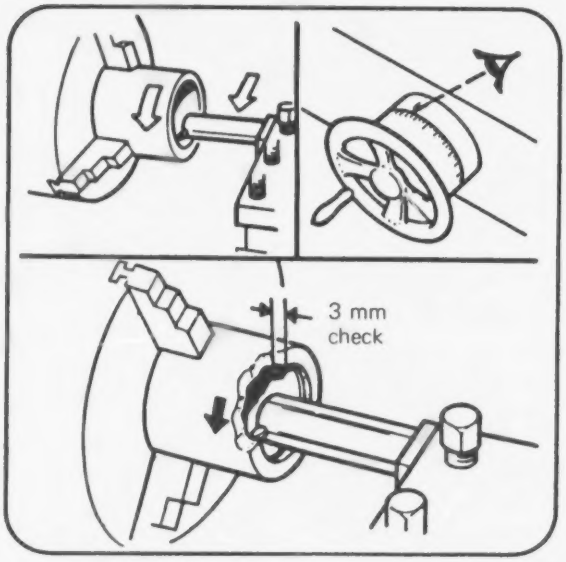
(d) Apply coolant and engage saddle traverse.

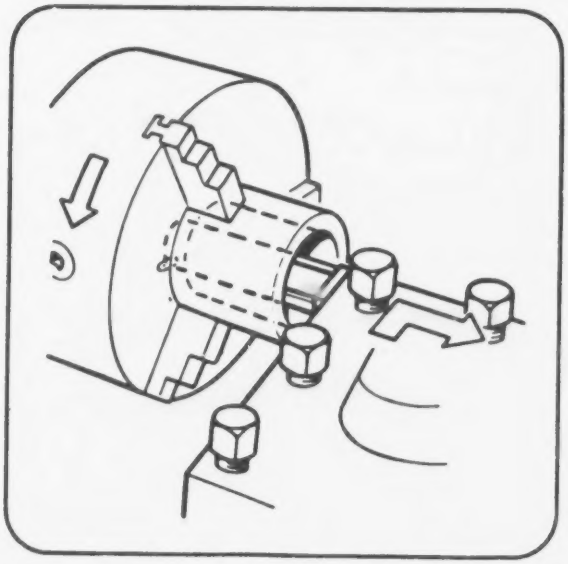
(e) If cutting action is correct, see clean bright curls of swarf removed and note even cutting sound.

(f) Check bore size with calipers when full cut is approximately 0.8mm in from face.

(g) As tool clears rear end of bore, disengage feed.







(h) Wind saddle to clear tool from bore.

(i) Stop spindle and check bore diameter.

5. Take trial cut
(a) Calculate cross slide index movement required to bore to size.

(b) Wind tool out to 0.15mm less than required calculation.

Note: This allows for tool spring during roughing cut.

(c) Start spindle.

(d) Wind saddle to almost touch tool to work face and engage feed.

(e) When tool is approximately 3mm along bore, disengage feed.

(f) Stop spindle and wind tool out of bore quickly before chuck stops rotating.

(g) Check diameter of 3mm deep cut.

Note 1. If bore is correct size.
(a) Start spindle.

(b) Engage traverse and feed cut through.

(c) Disengage feed at end of cut.

(d) Note index reading on cross slide.

(e) Wind tool in towards bore centre to clear wall of bore.

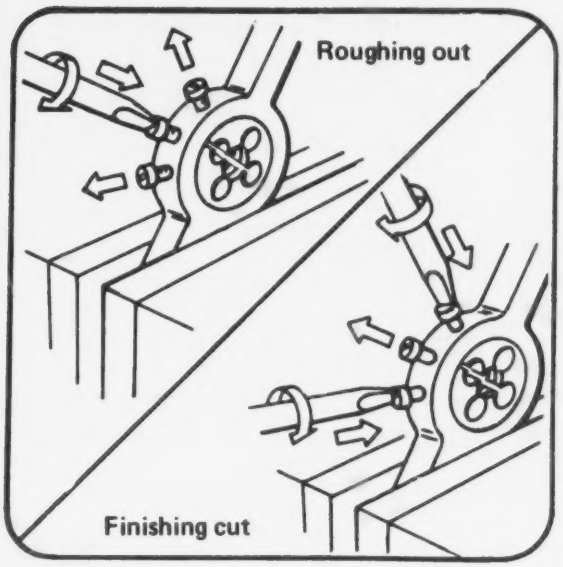
(f) Wind saddle to clear tool from bore.

(g) Stop spindle and check full length of bore diameter.

Note 2. If bore is undersize.
Repeat as Note 1, (a) — (g)

(h) Wind cross-slide out to previous setting, plus half the amount left in bore.

(i) Bore hole.



Screwcutting using stocks and dies

For small thread sizes it is practical to cut the thread direct on to the diameter. For large threads a die is best used to clean up and to complete the form of a thread partially cut with a single point tool.

1. Prepare diameter to be threaded
(a) Turn to 0.075mm below nominal thread diameter.

(b) Apply cutting oil to work surface.

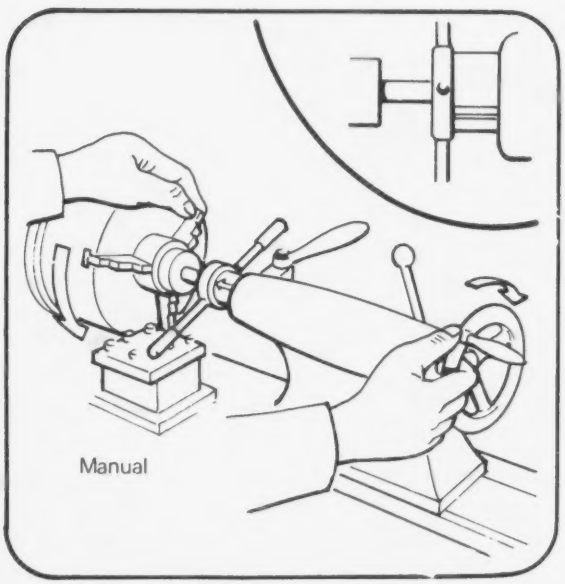
2. Set die in stock
Ensure that die fits squarely on to backface of stock recess.

3. Position tailstock to support die
(a) Fit diestock assembly on to the end of work diameter.

(b) Slide tailstock forward to hold diestock lightly in position. Lock tailstock to bed.

Note: Excess force will damage the die.

Safety
Ensure that machine is out of gear.



4. Cut thread
(a) Rotate chuck by hand until diestock handle contacts toolpost or cross-slide.

(b) Ensure that handle has a free path forward.

(c) Applying a light forward pressure on the die with the tailstock barrel pull the chuck round by hand to cut the thread to required length.

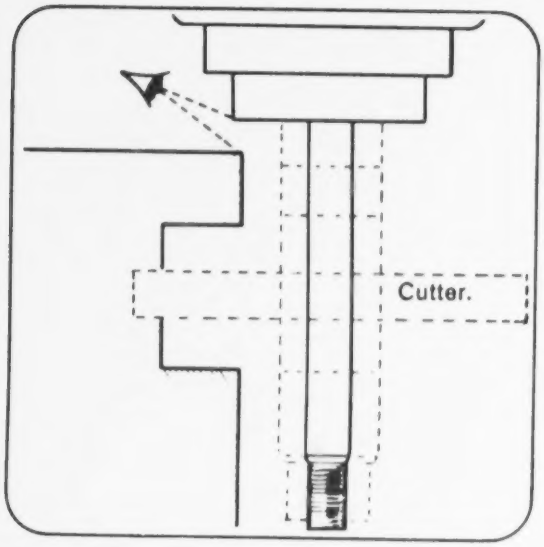
Note: It is important to keep tailstock barrel in contact with die for full thread length otherwise there is a likelihood of distorting the work.

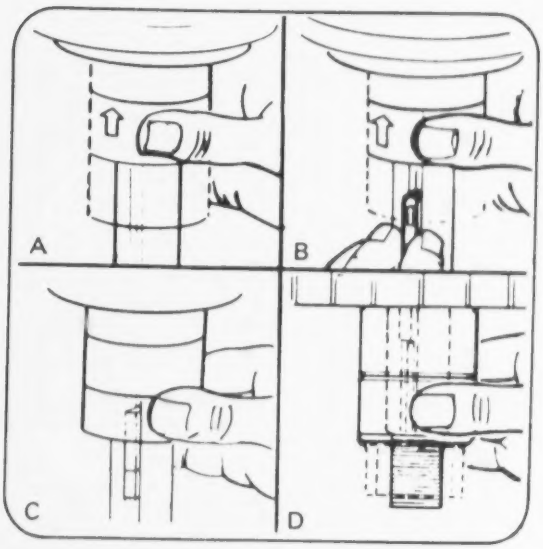
(d) Check thread for size using gauge or mating component.

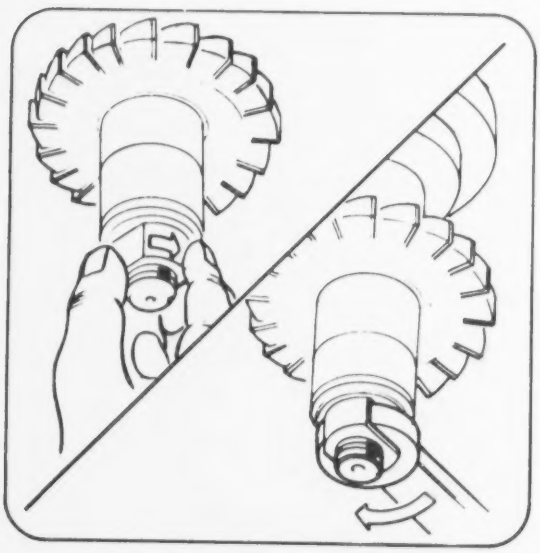
(e) Adjust die for second cut.

(f) Re-cut as above.

Note: An adaptor to hold the die in the tailstock may be available.







Engage cutters on a stub arbor

1. Engage arbor in machine spindle

2. Prepare arbor
(a) Hold bushes in position and remove securing nut.

(b) Remove collars and key from arbor.

(c) Clean collars and arbor faces.

3. Decide cutter position on arbor
(a) Refer to drawings and workpiece to decide the best position of the cutter to obtain the maximum possible rigidity but ensuring that the arbor and workpiece will be clear of any obstruction.

(b) Decide the number and width of collars to position the cutter in the correct position on arbor.

4. Engage cutter on arbor
(a) Slide collar/collars up to shoulder of arbor one less than number required to position cutter. (A)

(b) Fit key in arbor keyway, ensuring that key will protrude into collars at each side of cutter. (B)

(c) Align keyway in collar to key in arbor and slide collar on arbor. (C)

(d) Align keyway of cutter to key and slide cutter up to collars ensuring that cutting edge is facing in the required direction. (D)

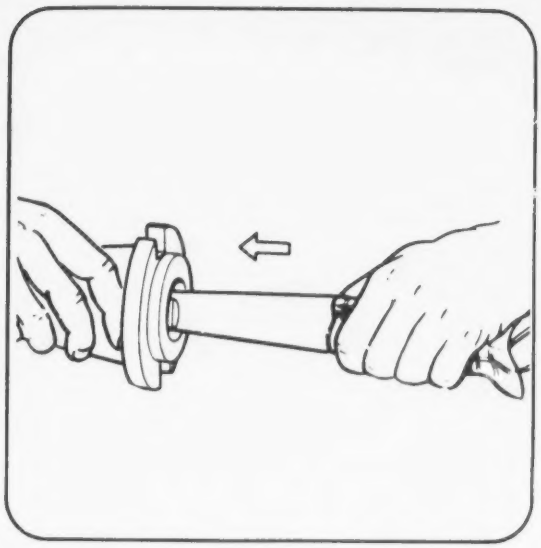
Note: Thin cutters should be held between two collars for easier sliding onto arbor.

(e) Align keyway and slide collar(s) on arbor.

(f) Visually check that collar just protrudes onto threaded part of arbor, but leaving sufficient thread to engage nut fully.

5. Tighten cutter on arbor
(a) Hold bottom collar up to keep cutter in position.

(b) Engage nut on thread and finger tighten. Moderately tighten nut with spanner.

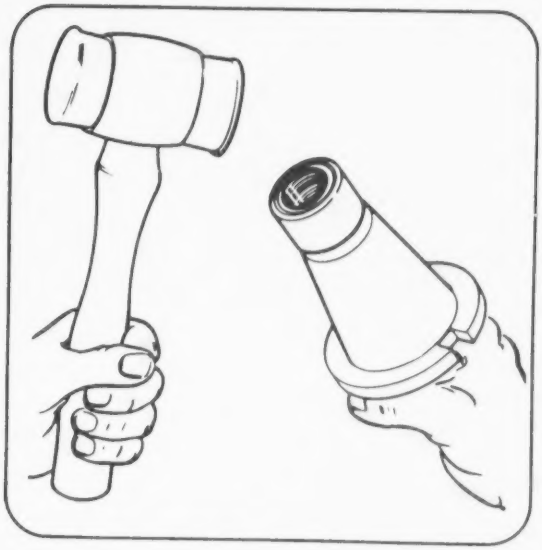


Engage taper shank cutters in machine spindle

1. Select arbor
(a) Use the shortest arbor possible.

(b) Ensure that the internal taper is the same as the cutter taper.

(c) If it is necessary to use taper sleeves keep the number used to minimum.

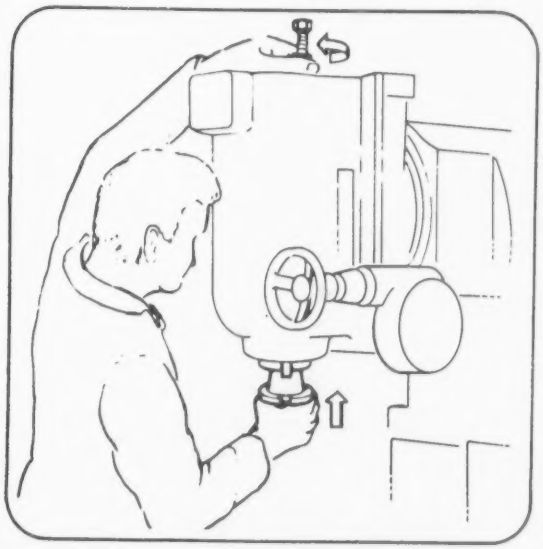


2. Engage cutter in arbor
(a) Clean taper in arbor and cutter shank and remove any burrs.

(b) Align cutter tang to slot in taper, and engage tapers with a sharp thrust.

(c) Tap cutter in with soft hammer.

Safety
Care of hands on sharp edges of cutters.



3. Engage arbor in machine spindle
(a) Clean both tapers.

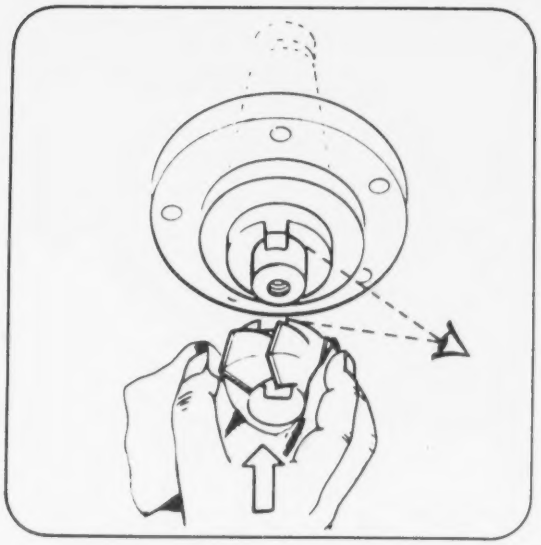
(b) Engage drive dogs in arbor slots.

(c) Hold cutter in position applying upward pressure.

(d) Screw drawbar firmly into arbor.

(e) Switch on machine.

(f) Rotate spindle at a moderate speed, to visually check that cutter runs true.



Engaging arbor mounted cutters — vertical machine

Engaging a face mill on arbor

1. Engage arbor in machine spindle.

2. Engage cutter on arbor

(a) Unscrew locking screw from arbor.

(b) Clean mating parts of cutter and arbor.

(c) Slide bore of cutter on arbor spigot, rotating cutter to align drive dogs to cutter slots.

(d) Feel drive dogs engage in slots and faces flat together.

Safety
Use wiper to protect hands from sharp edges of cutter.

3. Tighten cutter on arbor

(a) Hold cutter in position and screw locking screw into arbor finger tight.

4. Finally tighten locking screw

(a) Check that dogs of key and slots of screw head are not worn.

(b) Engage dogs of key in slots of screw head.

(c) Apply upward pressure to keep key engaged in slots and tighten screw.

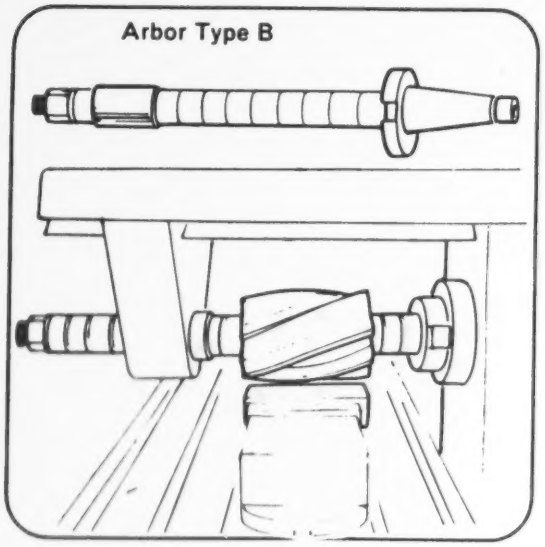
Safety
Worn keys, or screws with worn slots, must not be used.

Note: Shell end mills are engaged in a similar way except:

(a) A socket head set-screw is used as locking screw.

(b) The correct key must be used.

(c) A washer must be used between head of locking screw and shoulder of cutter.

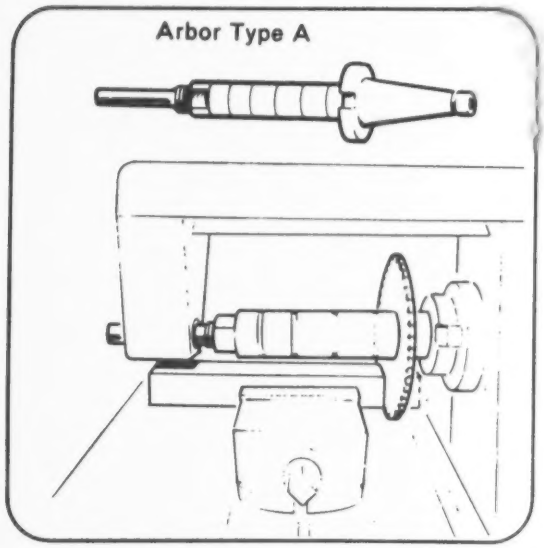


Engaging arbor mounted cutters — horizontal machine

Engaging cutter on long arbor

Use arbor type B when the top surface of the workpiece will pass between the arbor flange and the steady.

Safety
When using arbor type B keep clothing clear of unguarded arbor nut.



Arbors of type A are used to enable the top face of a long workpiece to be raised to just below the diameter of the spacing collars without fouling on the steady. If arbor B was used in this instance exceptionally large diameter cutters would be required. The arbor nut may be either left or right hand thread. If possible select an arbor, the nut of which tightens in the opposite direction to the required cutter rotation.

Engaging a single cutter on long arbor type B

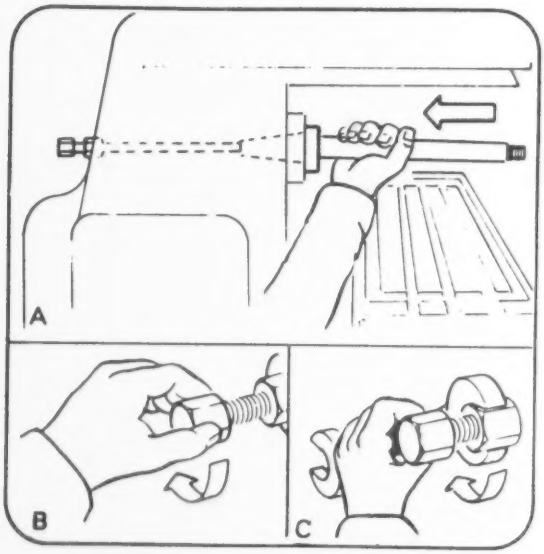
1. Engage arbor in machine spindle

(a) Set machine in low gear.

(b) Clean taper bore of spindle and taper shank of arbor.

(c) Hold arbor approximately parallel to table surface.

(d) Engage arbor in machine spindle, rotating arbor to align drive dogs to arbor slots.

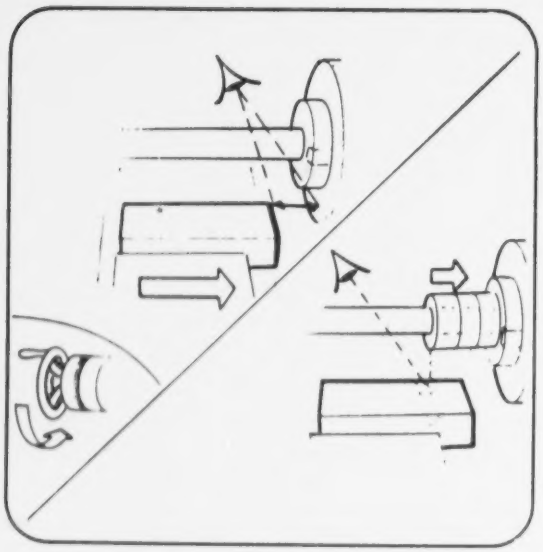


2. Tighten arbor in machine spindle

(a) Hold arbor shank in position in spindle.

(b) Screw drawbar well into arbor.

(c) Tighten drawbar locking nut with spanner.

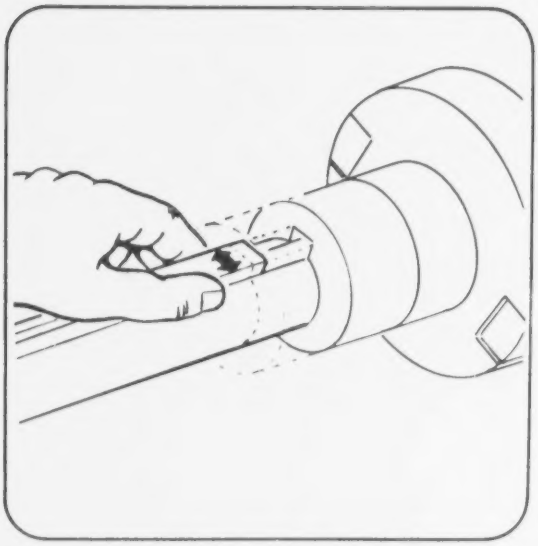


3. Decide cutter position
(a) Hand wind the machine table in, to position the workpiece close to rear of the machine.

(b) Visually check that the workpiece or work holding device will clear the front of arbor flange.

(c) Clean faces of collars and slide them on arbor pushing collars up to arbor flange.

(d) Visually check build-up of collars to see that outer face is level with, or protruding beyond face to be machined.



4. Fit key in arbor
(a) Remove outer collar from arbor.

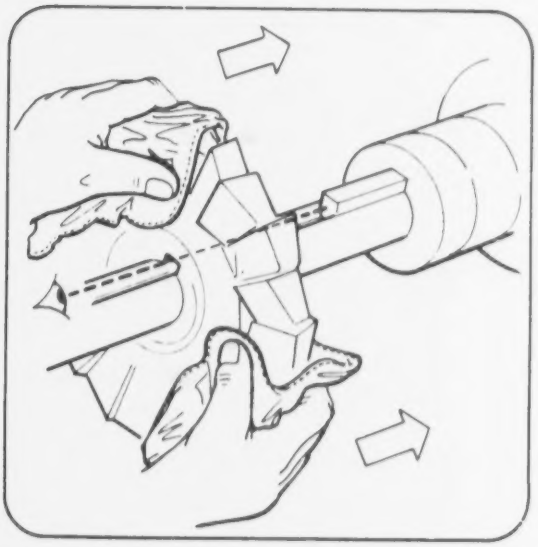
(b) Fit key into arbor keyway, feeling close sliding fit of key.

(c) Visually check that key will protrude into collar at each side of cutter.

(d) Replace collar on arbor rotating it to align keyway to key.

Note: When mounting thin saws on arbor:
(a) Omit fitting key in arbor. This allows the saw to slip if it gets trapped in workpiece.

(b) Trap saw between two collars when sliding onto arbor. This stops saw tilting and makes it easier to slide onto arbor.



5. Engage cutter on arbor
(a) Visually check that cutter is facing in direction of spindle rotation and slide cutter onto arbor.

(b) Rotate cutter, to align keyway to key, and push up to collars.

Safety
Protect hands from sharp edges of cutter.

6. Position arbor bearing collar
(a) Check position of cutter to face to be machined.

(b) Adjust table setting if necessary to correct positioning.

Note: If more than one part of the workpiece is to be machined, wind the table out to position the cutter to that part of the workpiece to be machined which is closest to spindle nose.

(c) Slide further collars onto arbor, rotating as necessary to align keyway to key.

(d) Visually check build-up of collars, until outer face protrudes beyond front extreme of workpiece.

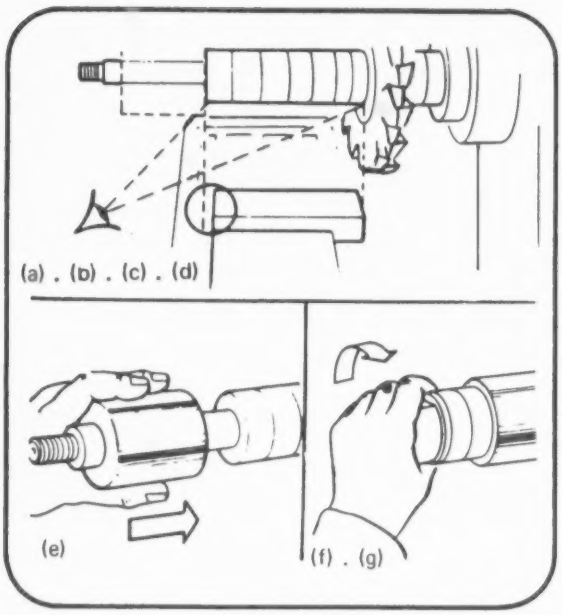
(e) Slide steady bearing collar up to collars on arbor.

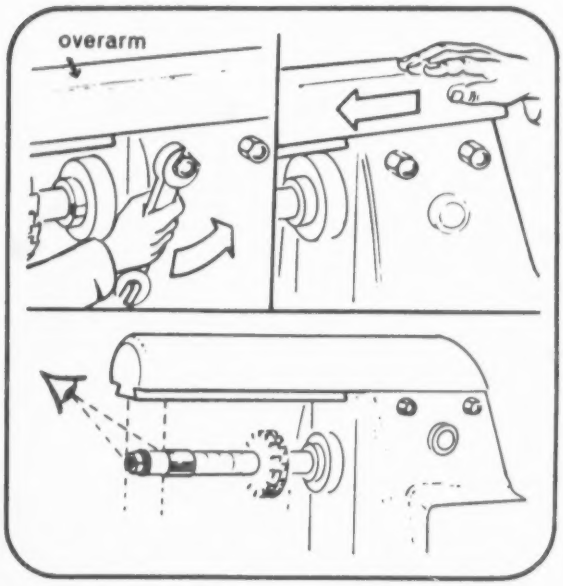
Note: The closer the steady bearing collar is positioned to the cutter the greater the rigidity obtained when steady is positioned.

(f) Slide further collars onto arbor until they protrude onto threaded part of arbor.

Note: One or more of these collars should be keyed to the arbor if the cutter has not been keyed. This ensures that the nut will not tighten if the cutter should slip.

(g) Visually check that sufficient thread protrudes for nut to be fully engaged. Engage nut and finger tighten.





7. Engage overarm steady
(a) Loosen overarm securing nuts.

(b) Slide overarm out visually checking that end protrudes beyond outer end of bearing bush.

(c) Wipe mating parts of overarm and steady.

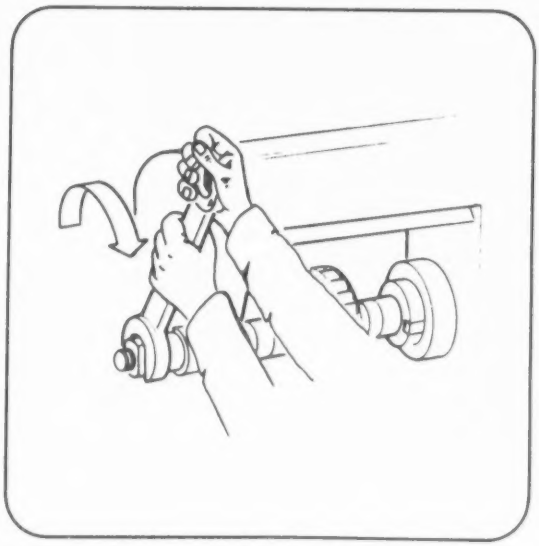
(d) Visually align mating parts of steady and overarm.

(e) Engage steady on overarm, sliding to position in which the front of steady is level with end of overarm.

(f) Tighten nut to secure steady on overarm.

(g) Slide overarm in, to position steady approximately central to length of bearing bush.

(h) Tighten overarm securing nuts tightly.



8. Finally tighten cutter on arbor.
Position spanner on nut with handle approximately vertical and tighten nut securely.

Safety
Do not use worn spanner or nut.

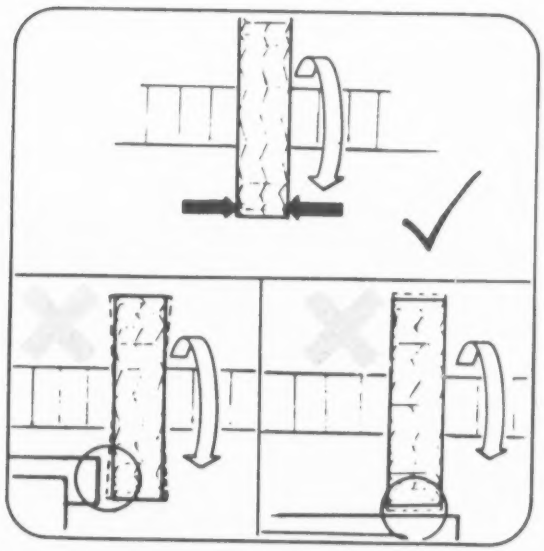
9. Check true running of cutter

(a) Check that cutter is clear of workpiece.

(b) Start machine spindle to run cutter at moderate speed.

(c) Align vision to side of cutter and a fixed part of machine or workpiece to see if cutter wobbles.

(d) Align vision to periphery of cutter and a fixed part of machine or workpiece to check concentricity.



Note: If the cutter wobbles:

(a) Check that the faces of the spacing collars, cutter, arbor and securing nut are clean and undamaged.

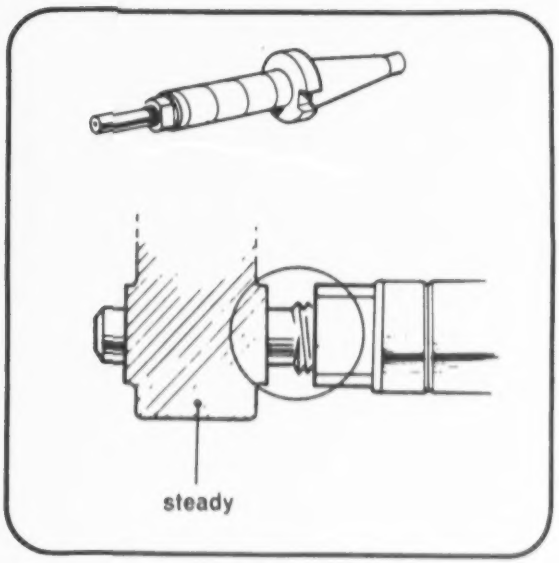
(b) Check that the arbor is correctly mounted and the tapers are clean and undamaged.

(c) Check that the faces of the spacing collars are parallel.

If the wobble is still present:

(a) The arbor may be bent. Check concentricity of arbor.

(b) The cutter may be incorrectly ground.



Engaging cutters on long arbor type A
Cutters are engaged on this type of arbor in exactly the same way as on arbor type B except:

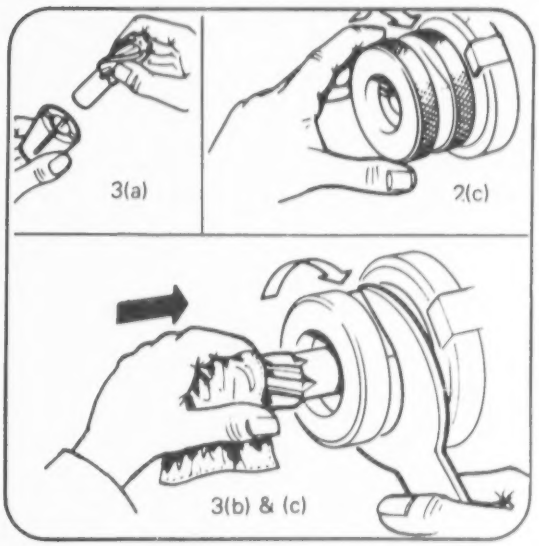
(a) No bearing bush is required. The pilot diameter runs in a bearing which is built into the steady.

(b) Visually check that the nut does not protrude on to the pilot diameter of the arbor.

(c) Visually check that the bearing in the steady is clear of the arbor thread.

(d) Visually check that the bearing in the steady does not protrude beyond end of pilot diameter.

(e) Key one or more of the collars between the cutter and the securing nut, if the cutter is not keyed to the arbor.



Mounting cutters in collet chuck
1. Engage collet arbor in machine spindle.

2. Engage collet in arbor
(a) Select collet the same size as cutter shank.

(b) Clean bore or arbor and bore and outside of collet. Position collet in arbor.

(c) Screw nut on arbor until light contact is felt of nut on face of collet.

3. Engage cutter in arbor
(a) Insert cutter shank into collet.

(b) Slide shank into collet until end of shank is felt at rear of arbor.

(c) Hold cutter in position and tighten nut as tight as possible using special spanner.

Milling

Speeds and feeds

Cutting speed

The cutting speed for a metal removal operation is the speed at which the cutting edge or tooth passes over the workpiece and is usually expressed in:

(a) metres per minute (m/min) Metric

(b) feet per minute (ft/min) Imperial

Conversion of cutting speed to revolutions of milling cutter

(a) Metric

$$\text{Revolutions of milling cutter (RPM)} = \frac{1000\ S}{\pi\ D}$$

where S = cutting speed (m/min)
D = diameter of cutter (mm)

(b) Imperial

$$\text{Revolutions of milling cutter (RPM)} = \frac{12 \times \text{Cutting speed in feet per minute}}{\text{Circumference of cutter in inches}}$$

Note: The speed at which material is removed depends upon the following factors:
1. The material being worked. (Hard and tough materials require a lower speed than soft and ductile materials).

2. Rigidity and condition of the machine and cutting tool.

3. Tool material. (Higher cutting speeds can be used for tungsten carbide tipped tools than those employed for high speed steel tools.)

Cutter feed

Cutter feed is generally expressed in:

(a) Millimetres per minute (mm/min) Metric

(b) Inches per minute (ins/min) Imperial

Factors influencing feed are:

1. Tooth pitch

2. Rigidity of workpiece and set-up

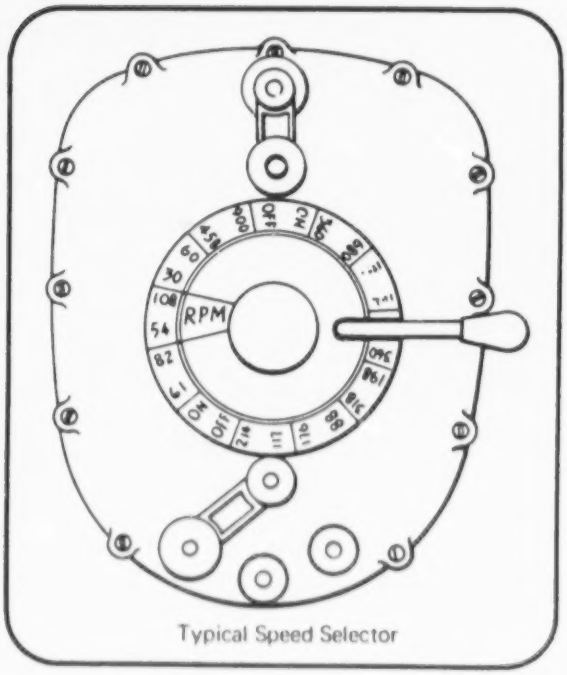
3. Machine condition

4. Quality of finish required

5. Cutter diameter

6. Type of material being worked

7. Width and depth of cut.



Typical Speed Selector

Speeds

The spindle speed is expressed in revolutions per minute (RPM).

Selecting spindle speeds

The range of spindle speeds available from the machine gearbox is usually shown on a circular scale which is rotated until the required speed is in line with a pointer. The position of this control varies according to machine type and may be mounted on the knee or on the column.

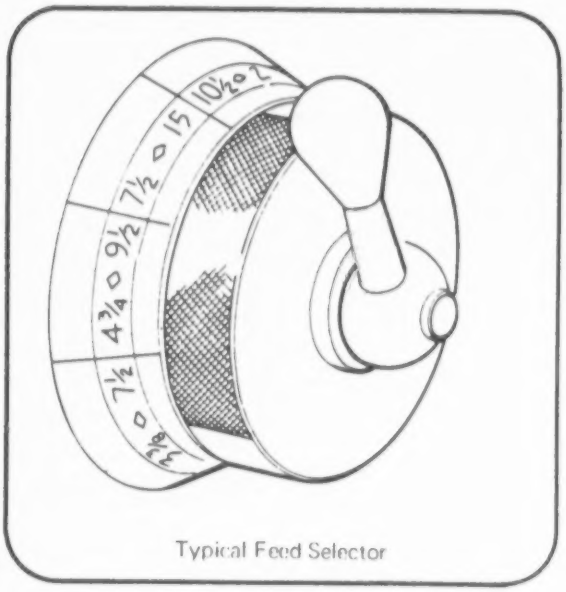
Feed

Selecting feed rate

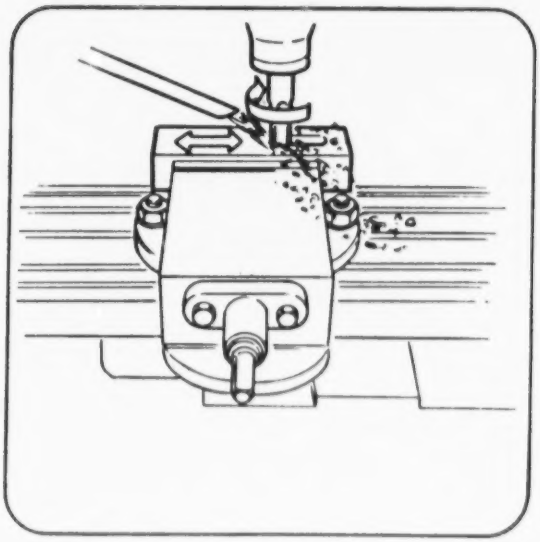
This is the rate at which the workpiece advances into the cutter.

Feed is usually selected on the machine gearbox by rotating a dial or circular scale until the required feed is in line with a pointer.

As with the speed selector, the position of this control varies with machine type.



Typical Feed Selector



Milling a keyway

1. Repeat sequences as for milling a slot (see Training Guide 1B Pages 23 and 24).

2. Set cutter to length of keyway.

(a) Engage and check concentricity of cutter.

(b) Touch end of workpiece with cutter using paper to show contact.

(c) Wind table the required length from end of workpiece, PLUS diameter of cutter, using table index.

(d) Set index at "zero".

(e) Wind table to the required length of keyway MINUS diameter of cutter, and mark index.

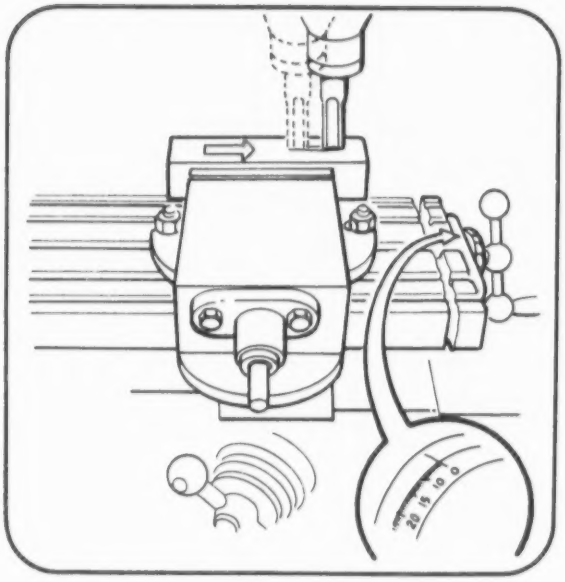
Note: Backlash must be accounted for when moving in reverse direction.

3. Set for depth and cut keyway

(a) Touch top of workpiece with revolving cutter marking the workpiece very lightly.

(b) Set vertical index at "zero".

(c) Remove metal in even cuts, until required depth is reached.



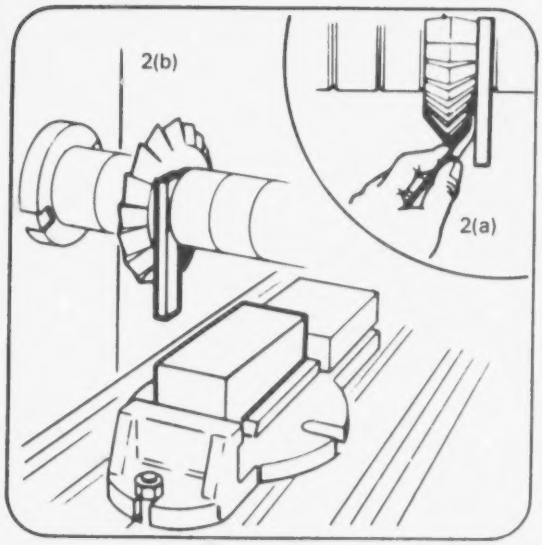
(d) Use plenty of coolant to aid swarf clearance.

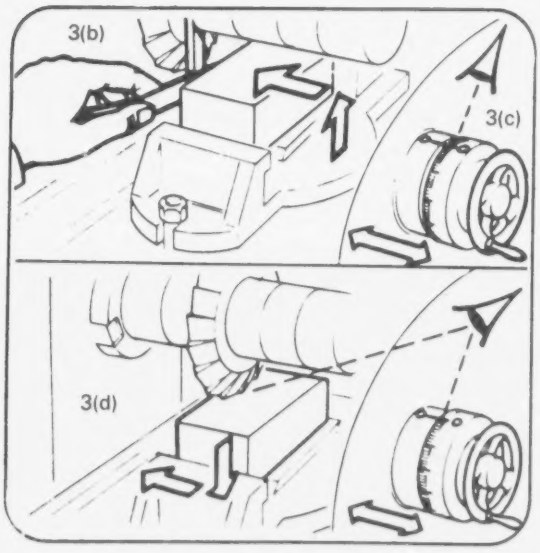
(e) Switch off machine.

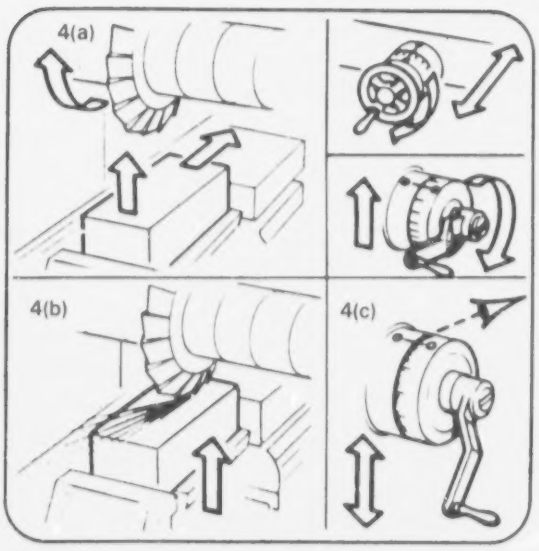
4. Check width and length of keyway

(a) Check width of keyway with slip gauges, also check length with a rule or vernier caliper when a depth of 1.5mm has been obtained.

Note: The operation can be carried out on a horizontal machine by selecting a workholding method to position the workpiece at the rear of machine table, e.g. dividing head, vice, clamps, and the slot drill mounted in the machine spindle. Alternatively, if the keyway runs through the workpiece endwise, a side and face or slot cutter is mounted on the arbor, and workpiece positioned approximately central across machine table.







Milling vees with equal angle cutter

1. Mount cutter on arbor

2. Prepare arbor for cutter positioning

(a) Loosen arbor locking nut, and insert a small parallel bar, between cutter and collar.

(b) Ensure that parallel protrudes approximately 6mm below diameter of cutter.

(c) Tighten arbor locking nut.

(d) Check between cutter boss and parallel, with feeler gauge, to ensure a good seat.

3. Position cutter to workpiece

(a) Bring parallel close to end of workpiece.

(b) Insert a feeler gauge between parallel and workpiece, and gently move across slide to lightly trap it.

(c) "Zero" the index. Drop table to clear parallel from workpiece.

(d) Wind cross slide the required distance to position centre of cutter. Reset index on "zero".

$$\text{Distance of centre of vee from end of workpiece} + \frac{\text{width of cutter}}{2} + \text{Thickness of parallel} + \text{Thickness of feeler gauge} = \text{Required distance}$$

(e) Loosen arbor locking nut, remove parallel, and re-tighten.

4. Set cutter for depth

(a) Bring cutter over face of workpiece.

(b) Raise table (cutter revolving), to bring cutter so that points of cutter lightly mark workpiece.

(c) "Zero" index.

5. Cut the vee

(a) Remove material in even cuts, until about 6mm depth has been reached.

(b) Use plenty of coolant, remove swarf with brush, (cutter stopped).

(c) Reduce depth of cut after 6mm depth has been reached.

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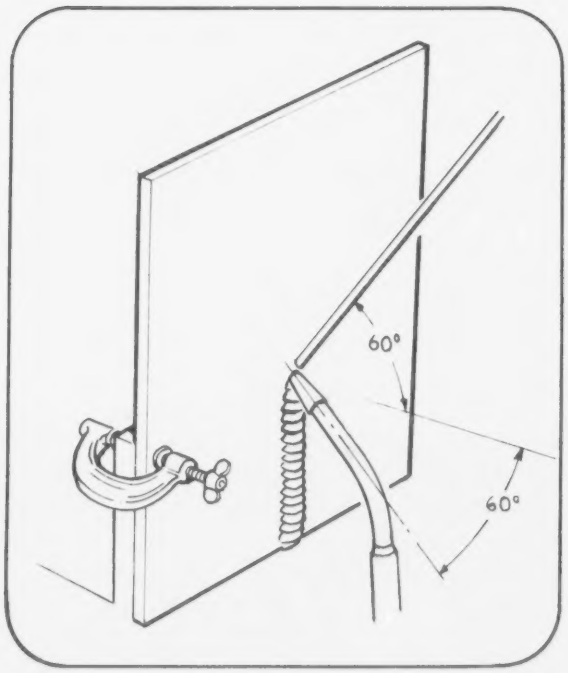
Oxy-acetylene welding

Deposition runs — Vertical upwards

Material	One piece of mild steel 1·6 mm thick. Min. size 200 mm x 100 mm
Filler rod	1·6 mm
Nozzle size	2 (57 litres/hr)



1. Position the sheet in a clamp, with the 200mm length vertical and with the bottom edge of the sheet at chest height.

2. Light the torch and set the valves to give a neutral flame.

3. Establish a weld pool at the bottom edge of the sheet.

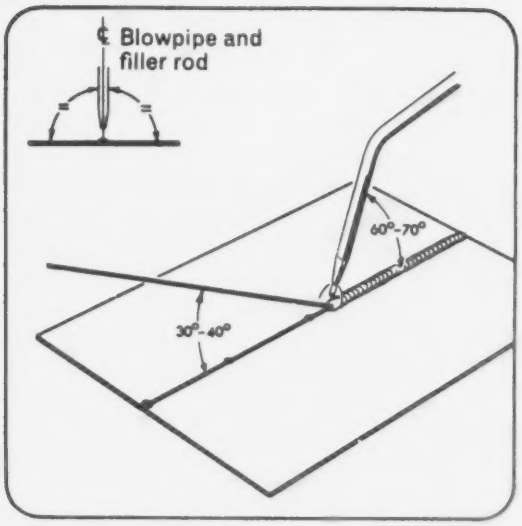
4. Using the torch and rod angles illustrated, move the torch vertically to fuse the sheet at the leading edge of the weld pool. Add filler metal to the weld pool to fill the crater.

5. Adjust the travel speed to achieve fusion of the sheet and to prevent collapse of the weld pool. Control filler metal additions to give correct surface profile.

Visual examination
The completed weld bead will be uniform and the weld profile free from undercut.

Oxy-acetylene welding

Open square butt joint



Material	Two pieces of mild steel 1.5 mm thick. Min sizes 100mm x 150mm
Preparation	square edge
Assembly	tack weld with five tacks; gap 1.5 mm. Support assembly about 15.0 mm above bench surface in flat position.
Nozzle size	2 (57 litres/hr. each gas)
Regulators	each 0.14 bars (2 lb/in^2)
Filler	1.5 mm BS 1453/A1

1. Commence welding at the right-hand end of the joint.

2. Direct the flame centrally into the gap with the blowpipe nozzle at an angle of 60^0 — 70^0.

3. Hold the filler rod in line with the joint at an angle of 30^0 — 40^0.

4. When tack weld and parent metal fuse locally, immediately add filler metal to establish weld pool across the gap.

5. Commence leftwards movement, co-ordinating addition of filler metal and rate of travel.

6. A slight transverse movement of the filler rod end will help to control the weld pool as the added filler metal flows to the edges, preventing excessive penetration.

7. Adjust rate of travel to avoid 'burn-through' and add filler metal to build up a weld bead proud of the sheet surface, behind the weld pool.

Visual examination

The welded assembly should be examined on the reverse side. Penetration to the full depth of the fusion faces, without excessive penetration bead and without 'burn-through' should be achieved.

The profile of the weld should be uniform and slightly convex.

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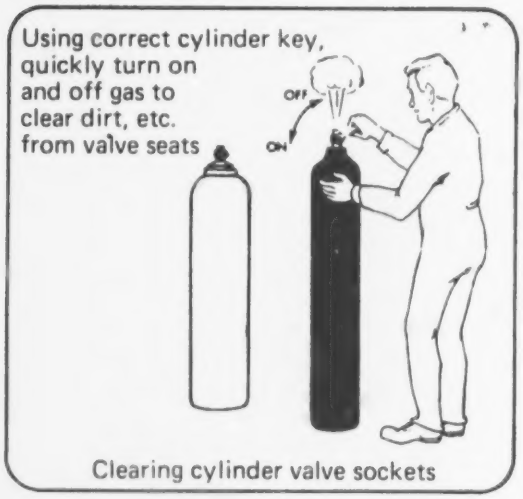
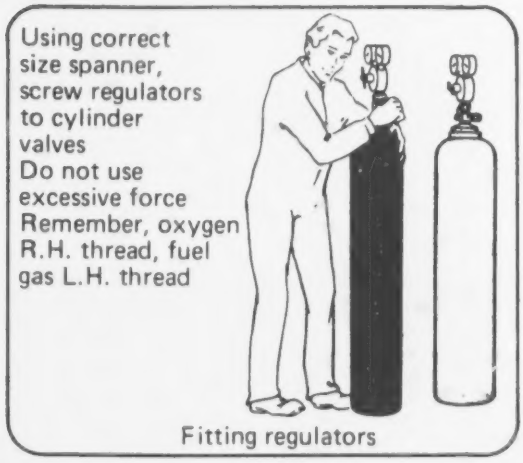
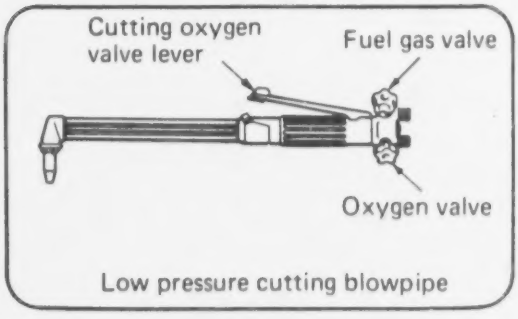
Gas cutting



Clearing cylinder valve sockets


Using correct size spanner, screw regulators to cylinder valves
Do not use excessive force
Remember, oxygen R.H. thread, fuel gas L.H. thread
Fitting regulators



Low pressure cutting blowpipe

Equipment
Special equipment additional to that described in Training Guide No. 1B (pages 28 to 35) is as follows:

Pressure regulators
1. The oxygen regulators must be capable of higher outlet pressures than those used for welding. Outlet pressures up to 4.8 bars (70lb/in²) are required for cutting plate up to 15.0cm thick. Pressures up to 8.3 bars (120lb/in²) may be required for heavier plate.

2. Regulators for propane must be capable of an outlet pressure of 2.08 bars (30lb/in²).

3. Acetylene regulators used for high pressure (dissolved) acetylene are suitable for both welding and cutting applications.

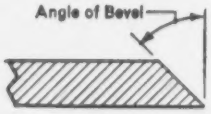
Blowpipes
1. Blowpipes for use with propane or acetylene fuel gas may be either of the injector type or nozzle mixer pattern.

2. Blowpipes may be constructed solely for cutting purposes or the shank of a welding blowpipe may be fitted with a cutting attachment.

3. Oxygen and fuel gas are mixed (as in the welding blowpipe) to produce the pre-heating flame. A separate supply tube conveys the additional oxygen required for the cutting operation. This cutting oxygen supply is controlled by a separate valve on the blowpipe.

Types of edge preparation

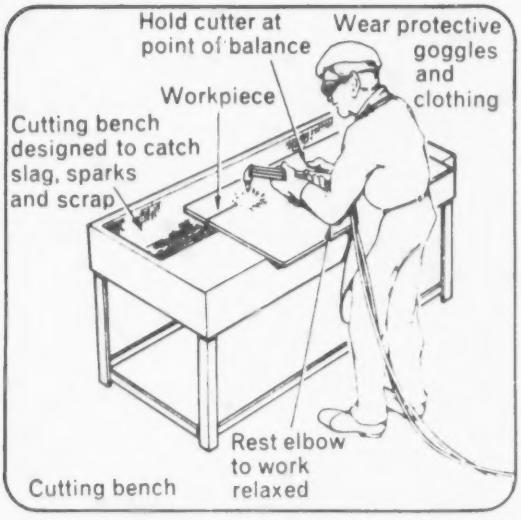
Square Edge Preparation
Edges of plate produced at right-angles by thermal cutting



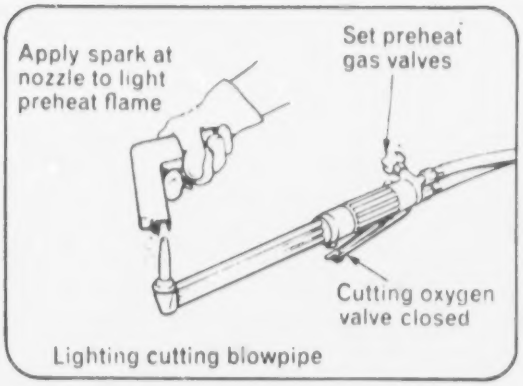
Angle of Bevel
The angle of bevel at which an edge or end is cut or chamfered.

Gas cutting

Safety
When cutting material make sure that the detached portion cannot fall and cause personal injury.
Wear safety boots to avoid injury from falling dross and hot metal.


Hold cutter at point of balance
Wear protective goggles and clothing
Workpiece
Cutting bench designed to catch slag, sparks and scrap
Rest elbow to work relaxed
Cutting bench

Safety
Do not remove the cylinder key from the fuel gas cylinder. It may be needed urgently for fire-prevention purposes.
Keep asbestos gloves available.


Apply spark at nozzle to light preheat flame
Set preheat gas valves
Cutting oxygen valve closed
Lighting cutting blowpipe

Operating the equipment

The following general instructions apply to gas cutting and gouging.

Always:

1. Comply with the prescribed safety precautions and fire-prevention procedure.

2. Check that the hoses are not kinked or otherwise obstructed.

3. Check that correct type and size of nozzle is fitted.

4. Check that cylinder valves are open.

5. Check that regulators are set to correct working pressures.

6. Use effective protective equipment and any necessary protective clothing.

7. Point the blowpipe in a safe direction when lighting and handle the lit blowpipe with due caution.

8. Extinguish blowpipe flame when not in use.

9. Follow closing-down procedure when equipment is not in use.

The cutting flame

The cutting operation results from the reaction of a jet of high purity oxygen upon a ferrous metal that has been pre-heated to ignition temperature. Oxygen rapidly oxidizes the metal in a narrow section that becomes the 'kerf' as the molten oxide and metal are removed.

Lighting the blowpipe

1. Close all valves on blowpipe.

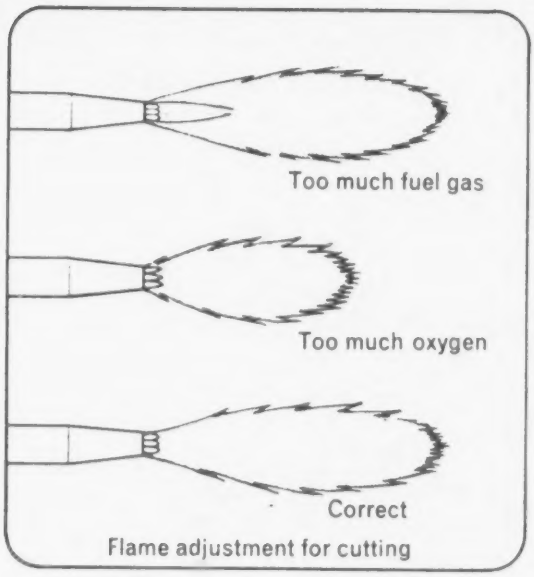
2. Open cylinder valves slowly by one turn of spindle.

3. Set the fuel gas regulator to correct working pressure.

4. Open the cutting oxygen valve and set the oxygen regulator to correct working pressure.

5. Close the cutting oxygen valve and open the fuel gas valve on the blowpipe about three-quarter turn.

Gas cutting



Flame adjustment for cutting

6. Wait a few seconds to flush system with fuel gas, pointing the blowpipe in a safe direction.

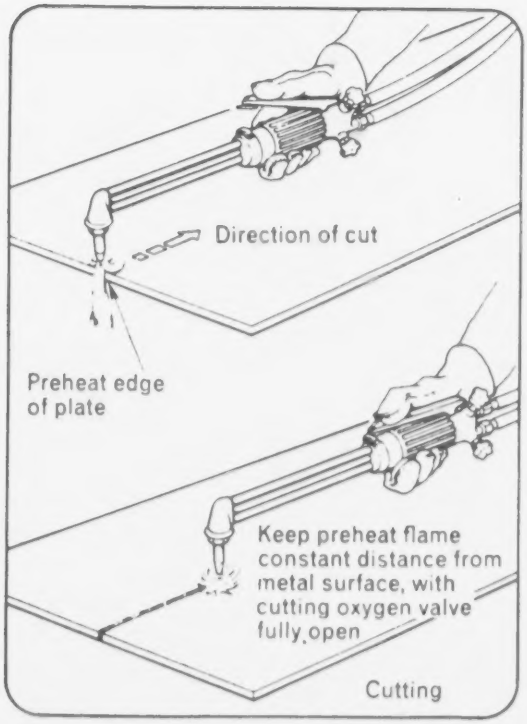
7. Use spark lighter to light fuel gas and adjust gas supply until flame ceases to smoke.

8. Open the heating oxygen valve and adjust until white inner cones in the flame are fairly sharply defined with slightly rounded tips.

9. Open the cutting oxygen valve and again adjust the heating gas controls to give a neutral flame. Close the cutting oxygen valve and the cutting blowpipe is ready for use.

10. To extinguish the flame:
(a) Turn off the cutting oxygen
(b) Close the fuel gas control valve
(c) Close the heating oxygen control valve.

NOTE: **Always follow the procedure in the order stated above.**

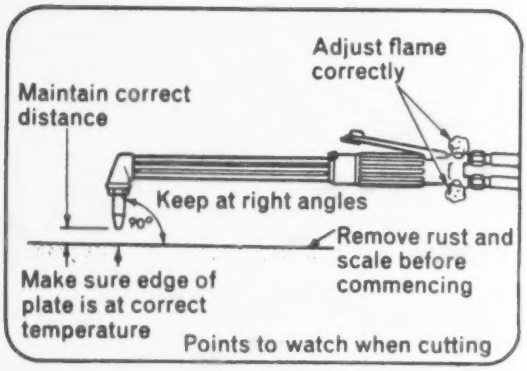

Direction of cut
Preheat edge of plate
Keep preheat flame constant distance from metal surface, with cutting oxygen valve fully open
Cutting

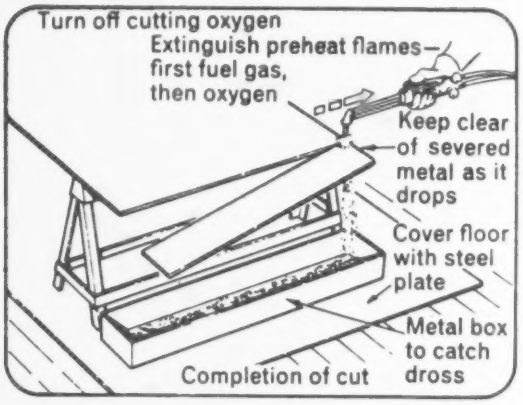
Freehand Cutting

Blowpipe Control

Material	12.5 mm mild steel
Preparation	clean surface where cut is to be made. Mark the line of cut.
Assembly	Place plate in flat position on supports with metal box below line of cut to catch dross
Nozzle	1.25 mm (3/64")
Oxygen	2.08 – 2.42 bars (30–36 lb/in^2)
Fuel gas	Acetylene 0.14 – 0.21 bars (2–3 lb/in^2) Propane 0.21 bars (3 lb/in^2)

Gas cutting


Adjust flame correctly
Maintain correct distance
Keep at right angles
90°
Remove rust and scale before commencing
Make sure edge of plate is at correct temperature
Points to watch when cutting


Turn off cutting oxygen
Extinguish preheat flames—first fuel gas, then oxygen
Keep clear of severed metal as it drops
Cover floor with steel plate
Metal box to catch dross
Completion of cut

1. Using neutral pre-heating flame pre-heat the edge of the plate at the point where cut is to start.

2. Aim the flame vertically downwards with the tips of the white cones 3 to 5mm above the surface of the plate.

3. Hold the handle of the blowpipe so that it lies in the direction that the cut is required.

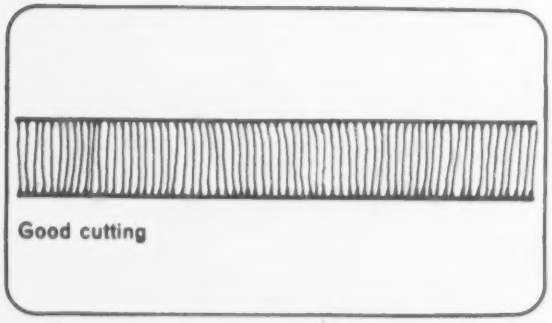
4. When the wedge is locally heated to dull red (with a small white hot spot) open the cutting oxygen valve slowly until full flow is obtained.

5. Move the blowpipe at a uniform speed along the line to be cut with the nozzle held at a constant distance from the plate surface. Focus the eyes on a point just in advance of the nozzle.

6. The cutting speed is correct when the dross sprays straight downwards.

7. Too slow a speed will cause the dross to spray forward in the direction of cutting.

8. If the blowpipe is moved too fast the white hot spot will disappear and the cut may fail to penetrate the plate. If this occurs turn off the cutting oxygen. Apply the pre-heating flame until the ignition temperature has again been obtained. Re-open the cutting oxygen valve and continue cutting.


Good cutting

Visual examination

A satisfactory cut has the following characteristics:

1. Sharp top edge.

2. Almost vertical drag lines, but not too pronounced.

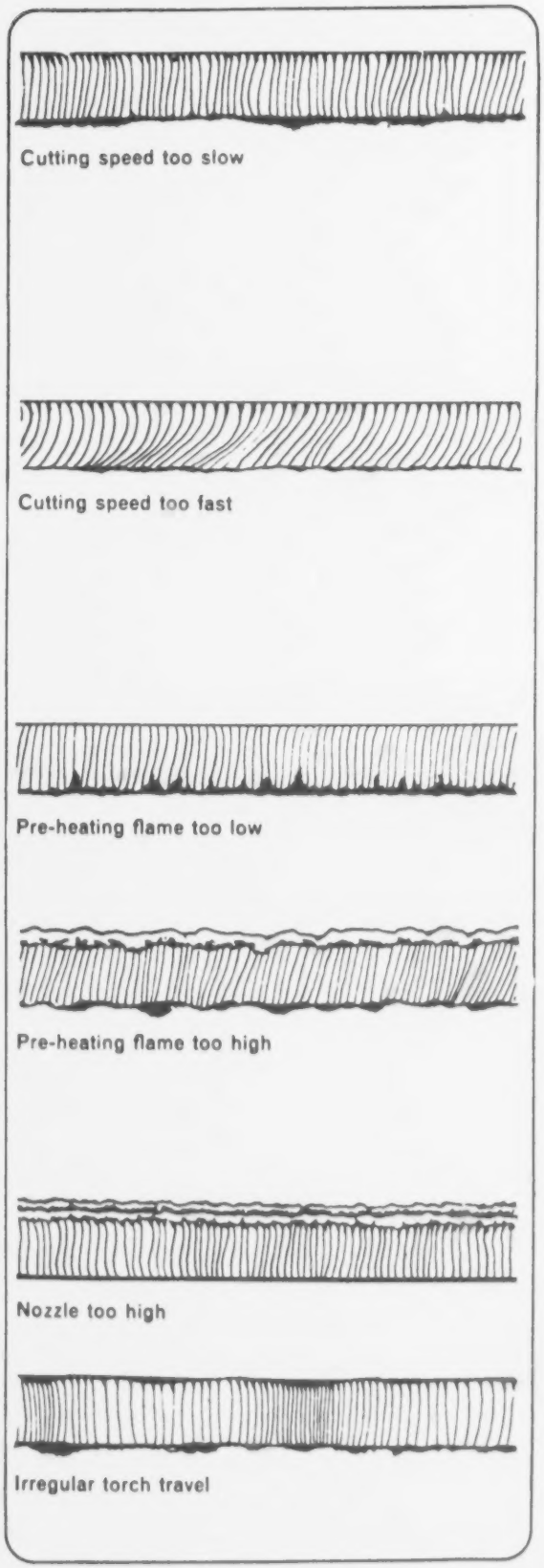
3. Square face with only a light and easily removable oxide scale.

4. Sharp bottom edge with no adhering dross.

5. Cut edge true to planned line of cut with uniform kerf width.

Examine the cut edge and consider the 'effects of variation in procedure' (page 62). Repeat the procedure until good quality cuts are readily obtained.

Gas cutting



Effects of variation in procedure

Cutting speed too slow
Indications:
1. Melted and rounded top edge.
2. Lower part of cut face fluted or gouged very irregularly.
3. Bottom edge rough.
4. Heavy scale on cut face.
5. Dross congealed on underside and difficult to remove.

Cutting speed too fast
Indications:
1. Top edge not sharp and may be undercut.
2. Drag lines very marked and uneven, sloping backwards.
3. Irregular cut edge.
4. Slightly rounded bottom edge which may not be completely severed at end of cut.

Pre-heating flame too low
Indications:
1. Slow cutting speed.
2. Bad gouging of lower part of cut face.

Pre-heating flame too high
Indications:
1. Rounded top edge with melted metal falling into kerf.
2. Cut edge irregular.
3. Excessive amount of tightly adhering dross on lower edge.

Nozzle too high
Indications:
1. Excessive melting of top edge.
2. Undercut at top of cut face.

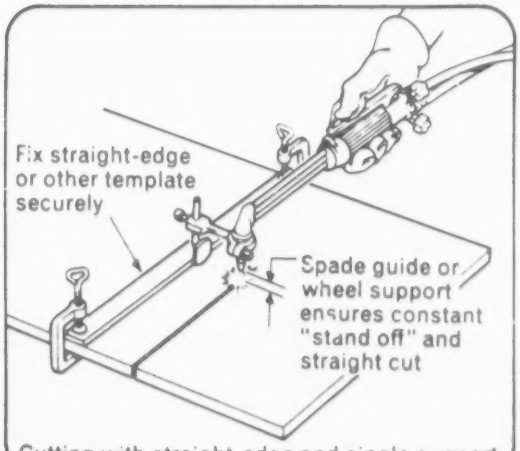
Irregular torch travel
Indications:
1. Uneven drag lines.
2. Wavy cut edge.

Gas cutting

Straight-line cutting

Square-edge cutting

Material	25 mm mild steel
Preparation	clean surface and mark line of cut
Assembly	place plate in flat position on supports. Fix straight-edge securely with clamps, parallel to and at the correct distance from line of cut
Nozzle	1.5 mm (1/16")
Oxygen	2.76 – 3.10 bars (40 – 45 lb/in^2)
Fuel gas	Acetylene 0.14 – 0.21 bars (2 – 3 lb/in^2) Propane 0.21 – 0.28 bars (3 – 4 lb/in^2)



Cutting with straight-edge and single support

1. Fit single support cutter guide to blowpipe and adjust to correct height.

2. Check that nozzle is centred over line of cut when cutter guide is in contact with straight-edge.

3. Light blowpipe and adjust to neutral pre-heating flame.

4. Pre-heat at point where cut is to start.

5. Open cutting oxygen valve and start cutting.

6. Keep the cutter guide resting on the surface of the plate and pressed sideways in light contact with the straight-edge.

7. Adjust cutting speed so that the dross spray is about vertical.

Alternative example

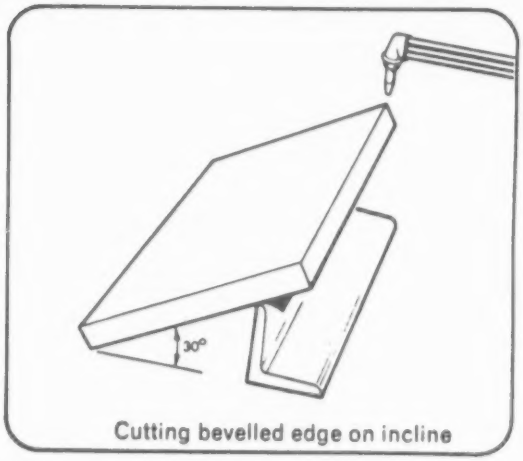
Material	6.5 mm mild steel
Preparation	as for previous exercise (above)
Assembly	
Nozzle	0.75 mm (1/32")
Oxygen	1.72 – 2.08 bars (25 – 30 lb/in^2)
Fuel gas	Acetylene 0.14 bars (2 lb/in^2) Propane 0.21 bars (3 lb/in^2)

1. As for previous exercise except for amended cutting conditions. Note that pre-heating time will be much shorter.

Visual examination

Examine the cut edges and note the effects of variation in procedure previously described. Repeat until good quality cuts are obtained.

Gas cutting



Cutting bevelled edge on incline

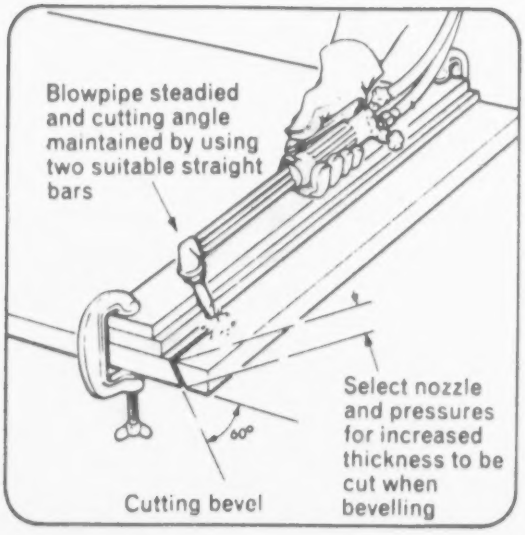
Bevel cutting

Effective bevel cutting depends upon the accuracy of edge preparation. Small pieces may be inclined at the appropriate angle and cut from the back.

The most common practice is to keep the plate in the flat position and angle the cutting nozzle by means of an adjustable cutter guide. Alternatively, two straight-edges off-set to give appropriate inclination can be used as a direct guide for the cutting nozzle.

30° Bevel cutting

Material	10 mm mild steel
Preparation	clean surface and mark line of cut at 10 mm distance from edge to be bevelled.
Assembly	place plate in flat position on supports. Fix two straight bars, parallel to and at the correct distance from the line of cut. Check that the off-set of the bars is such that when the blowpipe nozzle is in contact with the top edge of each bar it is inclined at 60°.
Nozzle	1.25 mm (3/64")
Oxygen	2.42 – 2.76 bars (35 – 40 lb/in^2)
Fuel gas	Acetylene 0.14 – 0.21 bars (2 – 3 lb/in^2) Propane 0.21 bars (3 lb/in^2)


Blowpipe steadied and cutting angle maintained by using two suitable straight bars
60°
Cutting bevel
Select nozzle and pressures for increased thickness to be cut when bevelling

1. Check that the nozzle is positioned so that its centre line (or longitudinal axis) intersects the line of cut when the nozzle is in contact with the off-set bars.

2. Pre-heat at point where cut is to start and proceed with the cutting operations.

3. Adjust rate of travel so that the dross spray is almost in line with the longitudinal axis of the nozzle.

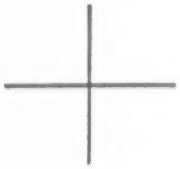
Electrical wiring

Electrical symbols
(extracted from BS 3939)

Alternating current at frequency shown
(Hz=Hertz=cycles per second)

Conductor

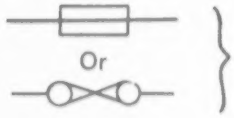
Three conductors shown by one line



One wire crossing another without connection

One wire connected to another

Conductors twisted together

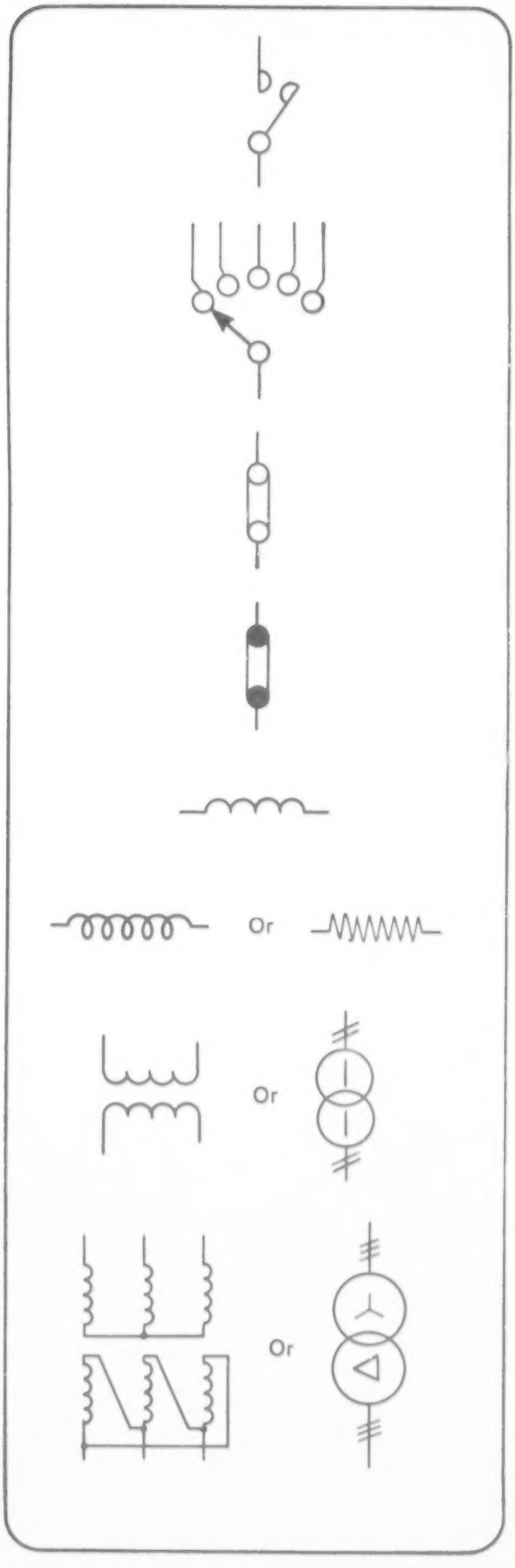


A fuse

A switch

A double pole switch in which both moving contacts are linked to operate together.

A two-way or changeover switch. Conductor 'a' may be connected by the switch to either wire 'b' or wire 'c'.



A contactor. Of similar function to a switch, but usually indirectly operated.

A multi-way switch giving connection to any one of a number of wires. In this case five are shown.

A connecting link with two readily separable contacts.

A link with two bolted contacts.

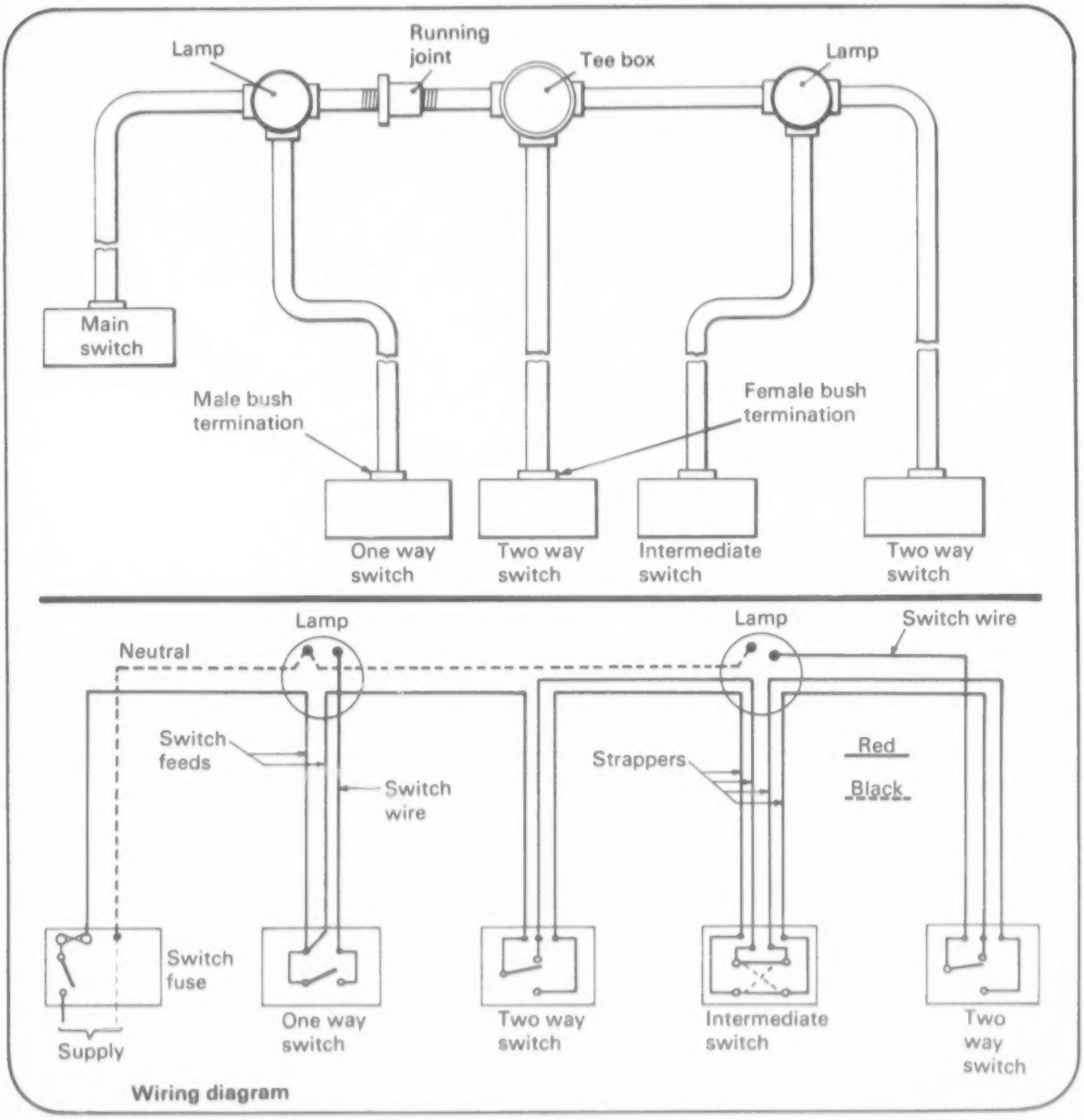
A winding of a transformer or other apparatus.
Note: This is the British standard symbol. Other symbols frequently used for a transformer winding are:

A single-phase transformer with separate windings.

A three-phase transformer. (In this diagram the connections are star-delta.)

Electrical wiring

Wiring diagram and assembly of a two lamp conduit system



Wiring diagram

Assembly procedure

1. Cut and bend conduit to required lengths. Thread ends and remove burrs.

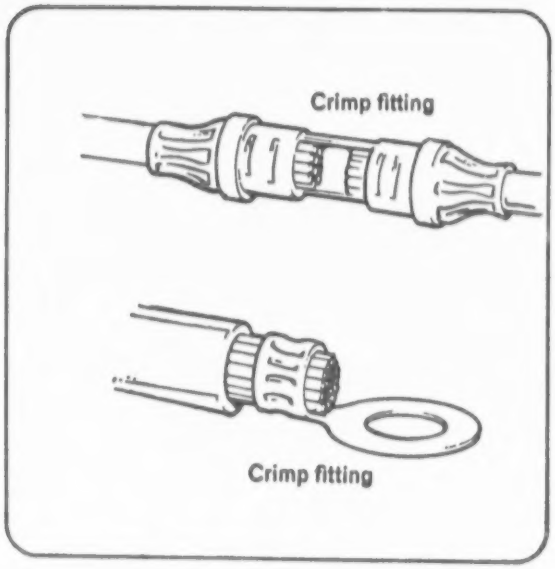
2. Assemble as shown above.

3. Wire to give one single way control of one lamp and one two way and intermediate control of the other lamp.

4. Test completed circuit.

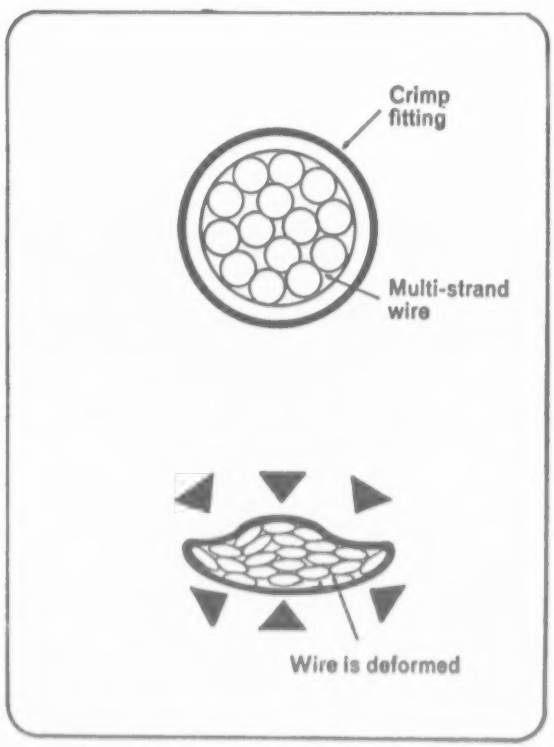
Note: Do not connect to the mains supply until the instructor has inspected the circuit.

Cable used is 1 mm² PVC single core.



Crimped joints

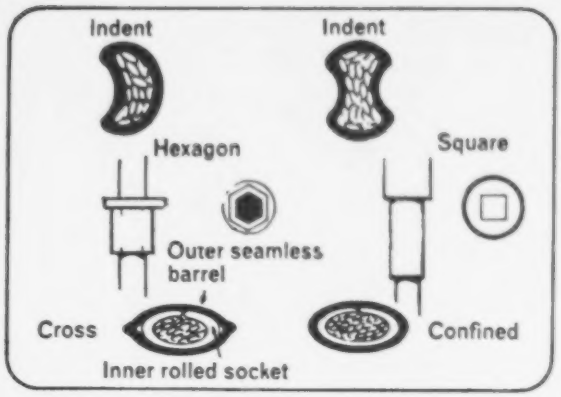
Crimped joints can be used to connect wires to each other or wires to wire terminations. The connectors used are called crimp fittings.



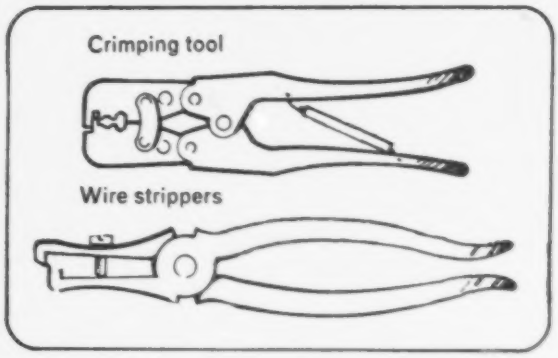
The crimp fitting is place around the wire and compressed (crimped) using a crimping tool.

The wire, usually multi-strand, must be a good fit to the crimp fitting.

A badly crimped joint cannot be re-worked. Scrap the fitting and use new wire.



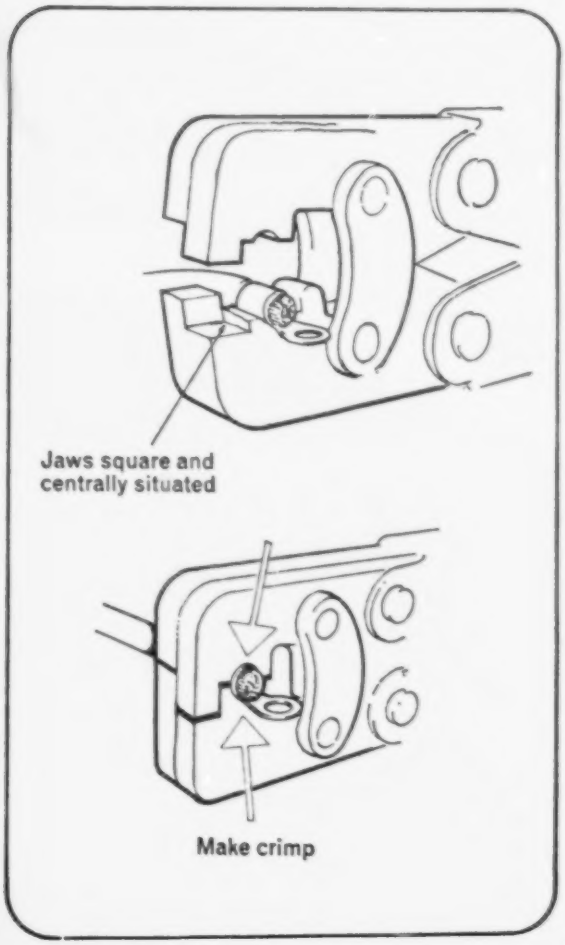
Types of crimping
Crimping shapes are determined by the shape of the jaws.



Making a crimped joint
A ring tongued terminal is to be crimped to the bared end of an insulated multi-strand wire using:

1. A hand operated crimping tool.

2. Wire strippers.

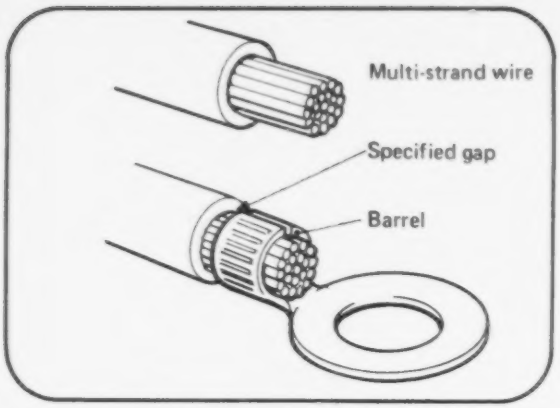


Making the crimp

1. Strip the insulation from the end of the multi-strand wire using the wire strippers.

2. If required, slightly twist the strands so that no whiskers are left.

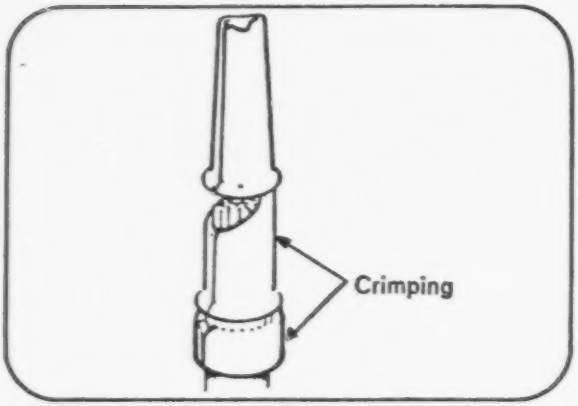
3. Place the terminal over the wire. Leave the specified gap between the insulation and the barrel.



4. Position the jaws over the barrel, ensuring that they are square to the barrel and centrally situated.

5. Make the crimp by squeezing the handles.

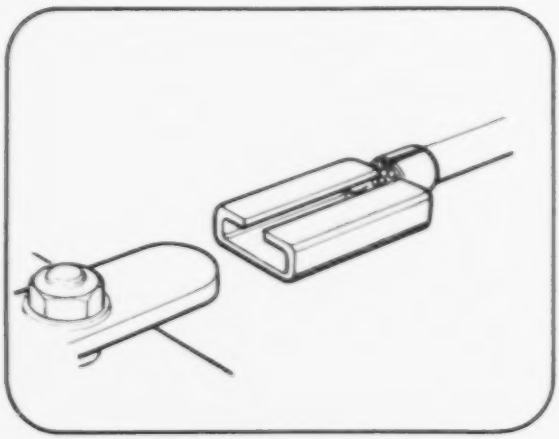
6. Release the tool by squeezing the handles still further. Open the handles and remove the tool from the joint.



Typical crimp fittings

The taper pin

Taper pins are used in miniaturised circuits. Crimping is applied to both the conductor and the insulation.



The edge connector

Edge connectors are used on printed circuit boards.

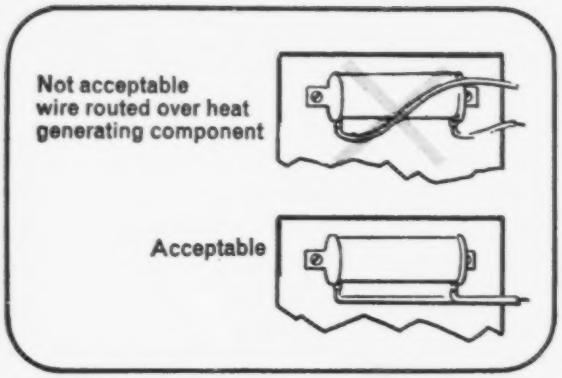
Electrical wiring

Correct location/orientation of components

There are a number of effects produced by electrical components which can influence the correct operation of other components in a circuit. The positioning of components in a circuit therefore needs careful consideration. Some examples are:

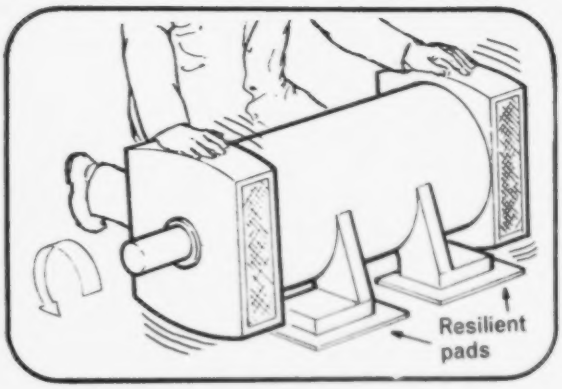
(a) Magnetic fields
Items which depend upon a magnetic field for their operation (eg relays) should not be situated close to components which produce a magnetic field.

(b) High voltage
High voltage terminals and connections should be positioned away from other conductors or parts of the assembly to avoid 'flashover' or breakdown.

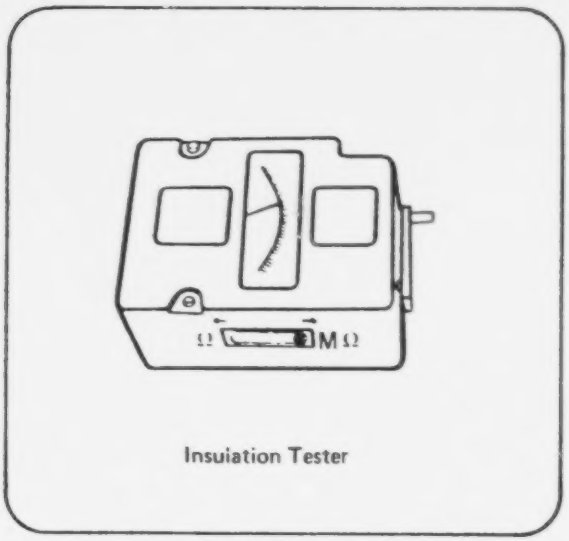


(c) Heat
Many electrical components produce heat and others may be affected by heat. The dissipation of heat must be considered when positioning components. Items such as hollow wire-wound resistors should be mounted vertically to allow free circulation of air.

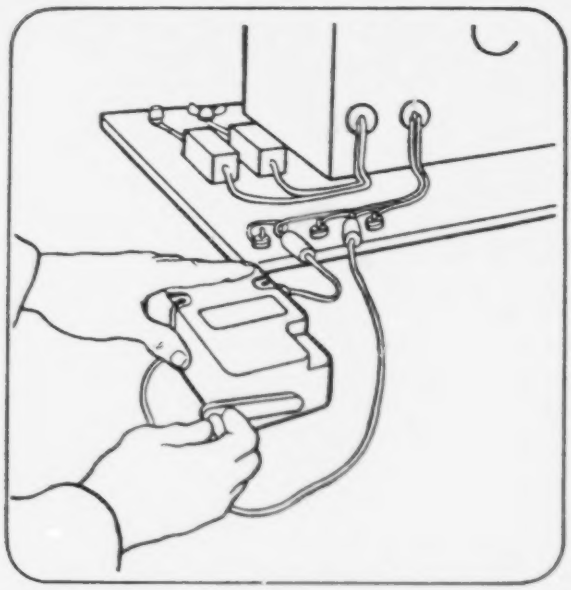
(d) Vibration
Items such as motors or circuit breakers which may produce vibration during operation should not be sited near other sensitive equipment.

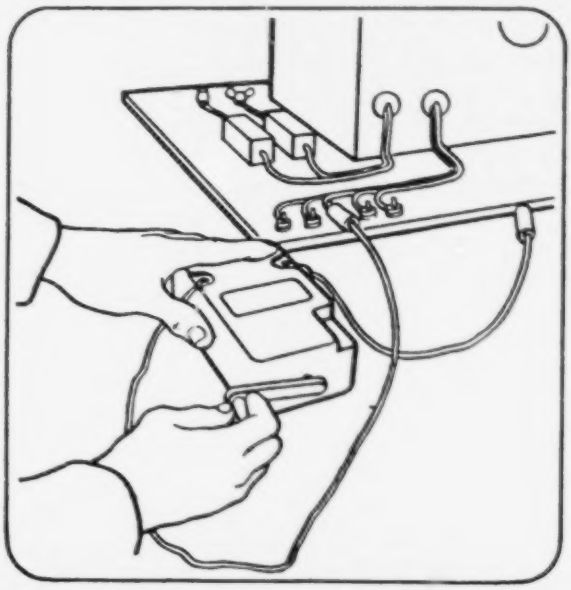


The need to keep inter-connections as short as possible will also affect the positioning of components which may also need to be accessible for servicing.



Insulation Tester





Electrical wiring

Insulation testing

Check with your instructor before carrying out any insulation tests.

The insulation tester is used for measuring very high resistances of the order of megohms. A constant voltage is applied to the leads or equipment to be tested by winding the handle of a generator in the instrument. The insulation resistance may be read direct from the meter. Do not touch the leads during use because shocks can be experienced while the handle is being turned.

ACCORDING TO THE INSTRUMENT USED VOLTAGES UP TO 500 V ARE GENERATED.

These can give an unpleasant shock

AVOID ACCIDENTS — DO NOT MISUSE

1. Support the instrument firmly.

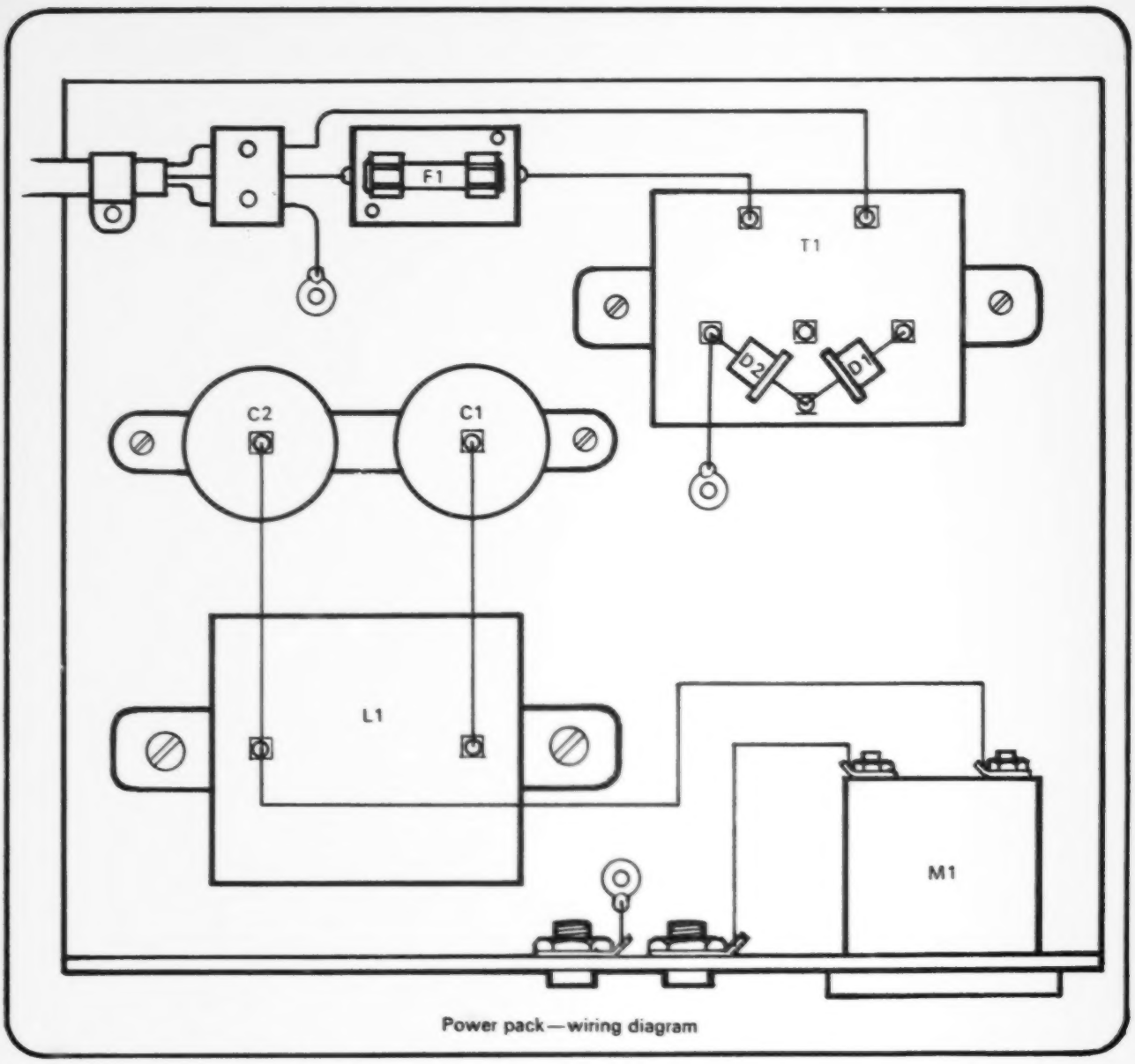
2. Rotate handle at a speed great enough to produce slipping of the driving mechanism.

3. Test between separate circuits.

4. Test each circuit to frame (earth).

Dual purpose instruments are available which will measure the resistance of joints and apply a high voltage for insulation testing.

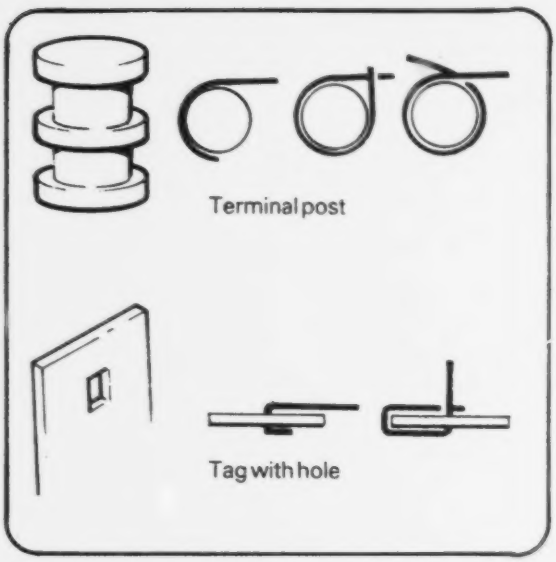
Note: Some insulation testers generate high voltages using electronic circuits. They are battery-operated and before being used should be checked in accordance with the manufacturer's instructions to ensure that the battery is in good condition.



Power pack—wiring diagram

A wiring diagram indicates the wiring between parts and may show their layout. Interconnections may be tabulated.

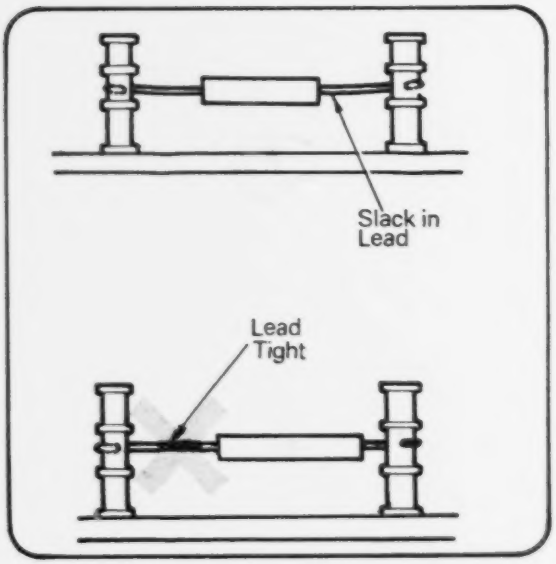
101



Terminating cables/wires to component boards and connectors

Mechanical reinforcement is the physical bond between the component lead and the connecting point prior to soldering.

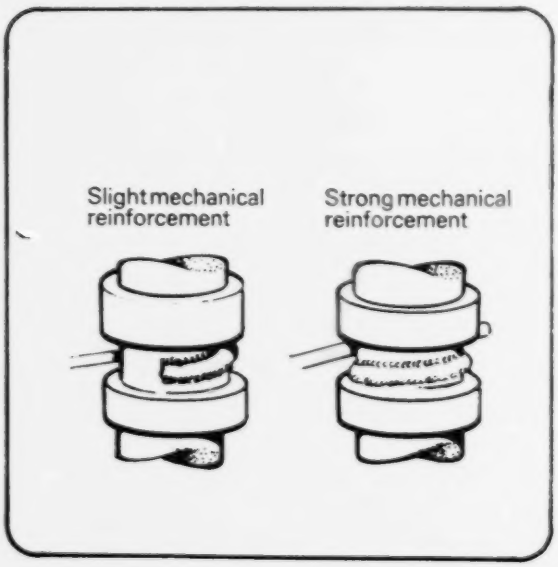
The degree of mechanical reinforcement required is specified on the drawings, or in general requirements specifications.



Ensure that components are mounted between terminals so that:

1. The leads are not under tension. Overtight leads will cause strain on the terminal, the joint and the component.

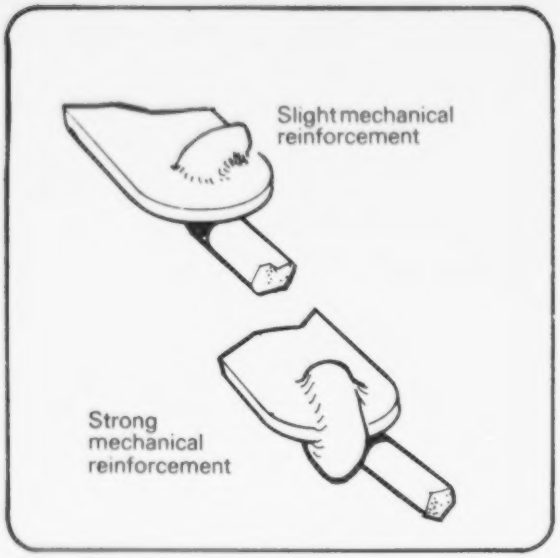
2. The component is positioned centrally between the terminals.



Leads on terminals

1. A wrap of 180° is usually specified where minimum reinforcement is required.

2. For a strong mechanical reinforcement a full wrap of 360° plus a tab is common.

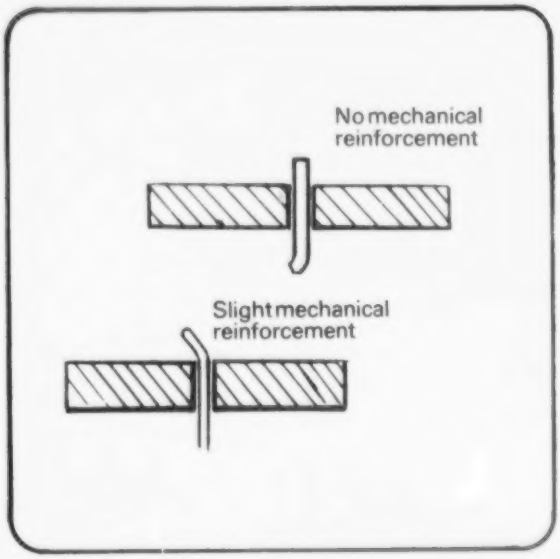


Leads through tag holes

1. The lead is usually bent over 90° or less to give easy removal.

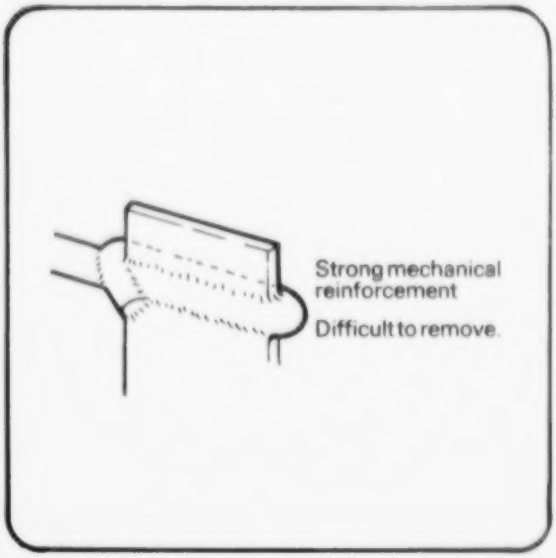
2. A full wrap of lead gives strong mechanical reinforcement.

Ensure that all wrapped leads are wrapped tightly.



Leads to plain tags

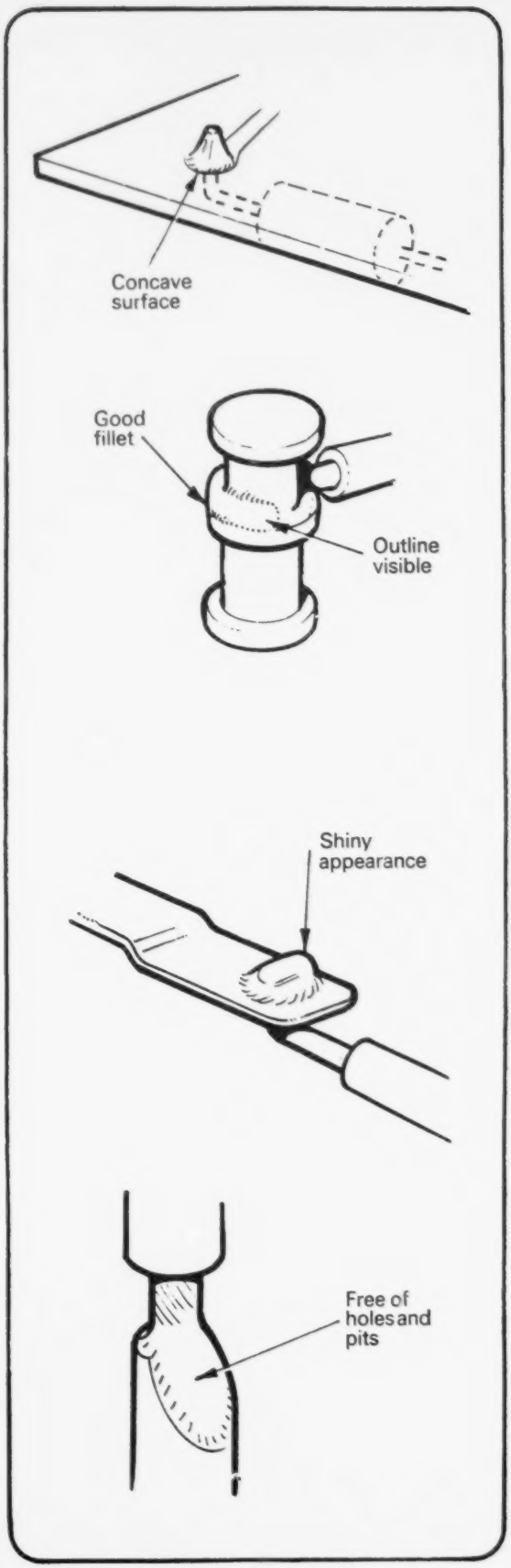
The lead is wrapped around the tag (360°) to give maximum mechanical reinforcement prior to soldering.



Leads through printed circuit boards

To give minimal mechanical reinforcement the lead is cropped off straight, or bent at a slight angle from the vertical.

Government specifications usually call for an angle of not more than 30° from the vertical.



Good soldered joints
A good soldered joint:

1. Has a bright shiny appearance, and is free of surface flux.

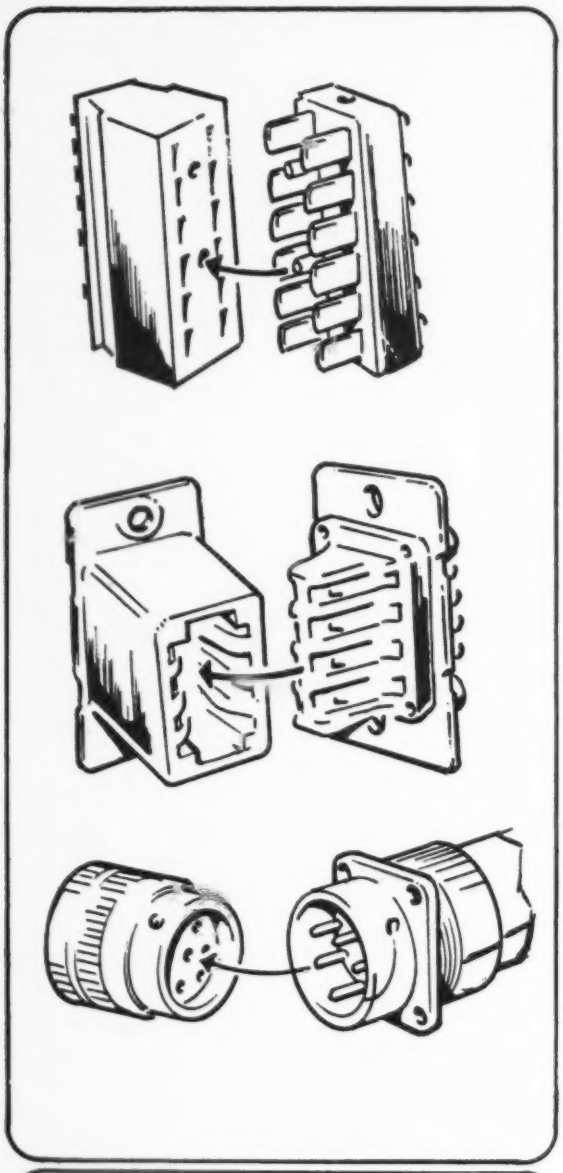
2. Is free of holes, scars or spikes.

3. Has a good fillet between conductor and terminal.

4. Has a concave surface.

5. Leaves the outline of the conductor clearly visible.

See page 86 in Training Guide No. 1B.



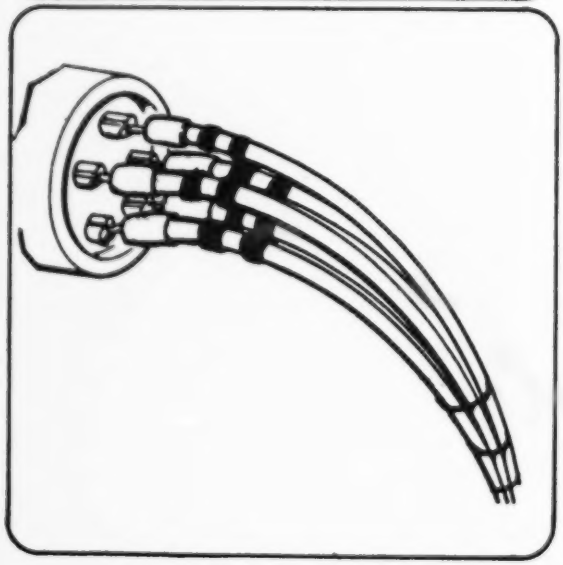
Plug and socket connectors
Plug and socket connectors are usually assembled to the cableform during cableforming.

Some typical plugs and sockets:

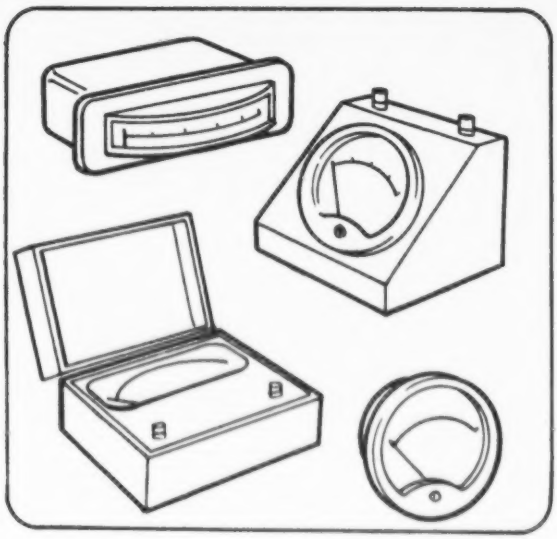
Blade connectors.

Spring connectors.

Shrouded pin connectors.



The cableform wires are usually soldered to the connector pins.

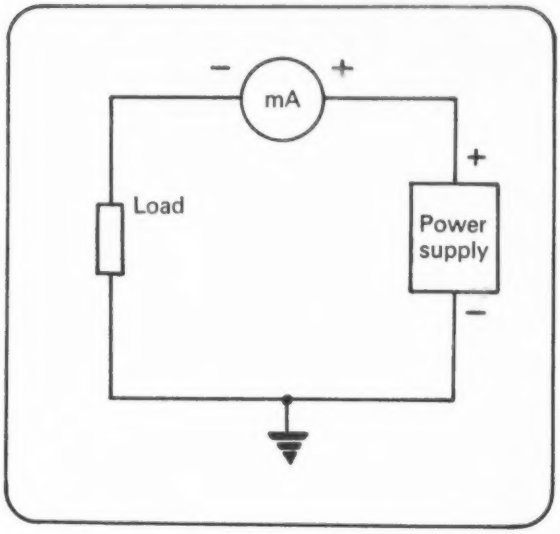


DC ammeters

Use a dc ammeter to measure direct current (dc) in amperes (A).

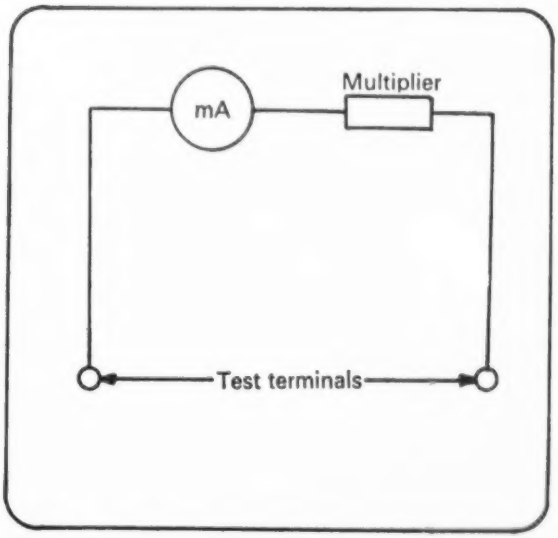
Where the current to be measured is less than 1A:

Use a milliammeter or microammeter.



The simplest milliammeter or microammeter consists of a moving coil movement only.

The meter is connected in series with the circuit load.

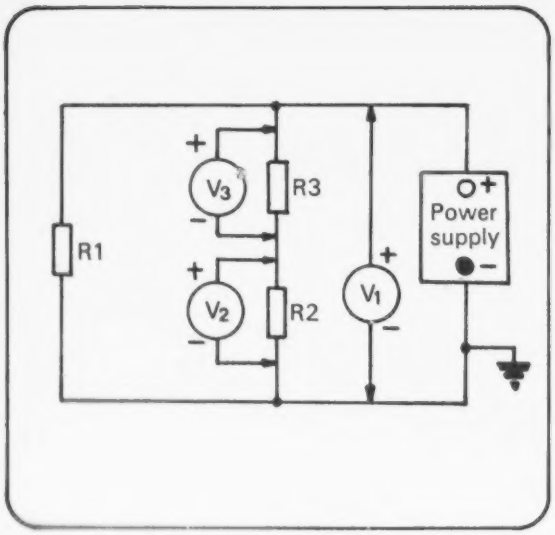


DC voltmeters

Use a dc VOLTMETER to measure dc potential difference.

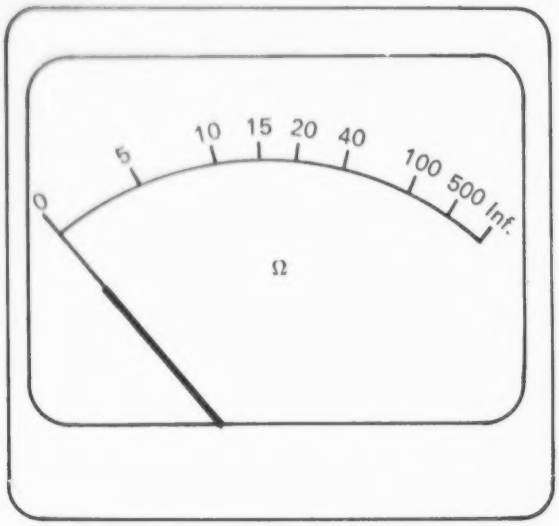
The simplest voltmeter consists of a moving coil milliammeter or microammeter with a resistor connected in series with the movement.

The resistor is called a MULTIPLIER.



To measure potential difference:

Connect the voltmeter IN PARALLEL with the circuit or component across which the potential difference is to be measured.



Ohmmeters

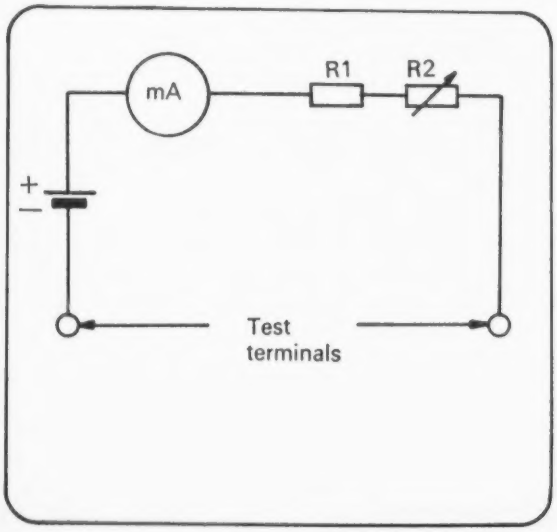
Use an OHMMETER to measure:

1. Resistance.

2. Circuit continuity.

Resistance is measured in OHMS (Ω), KILOHMS (KΩ) and MEGOHMS (MΩ).
The accuracy of measurement varies between approximately 5% and 10% depending on the part of the scale used.

The highest accuracy is obtained near the centre of the scale.



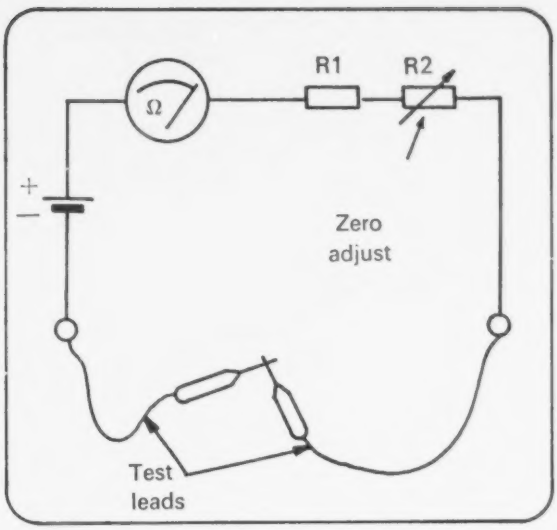
Series-type ohmmeter
A series-type ohmmeter consists of:

1. A milliammeter or microammeter.

2. A fixed resistor R1.

3. A variable resistor R2.

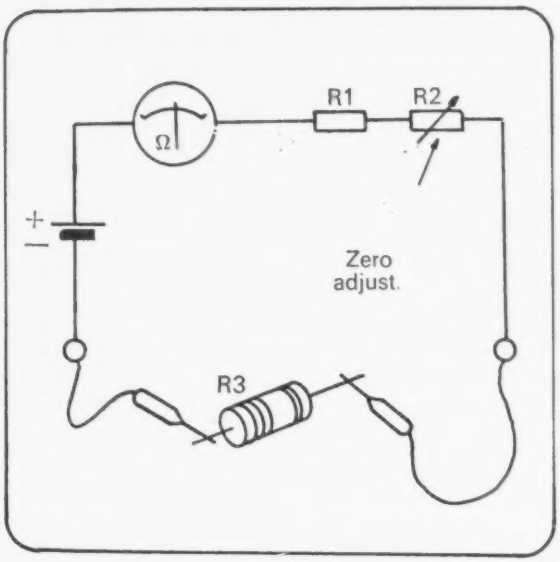
4. A battery.



Current flows in the ohmmeter circuit when the test leads are connected together.

R1 limits the current so that the meter indicates approximately full-scale deflection.

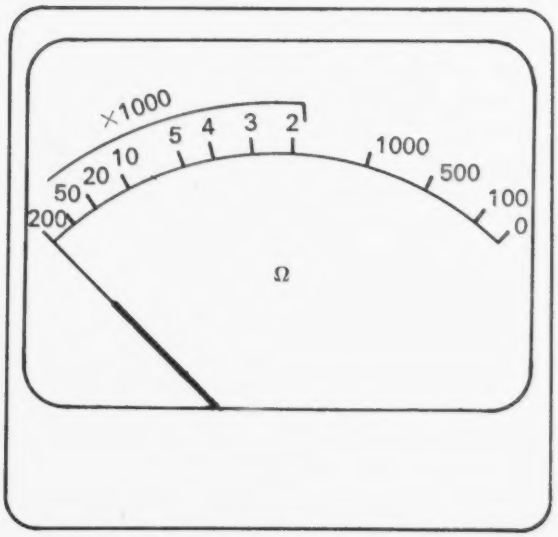
The deflection is made exactly full-scale by adjusting the ZERO ADJUST control, R2.



The test leads are connected across the resistance to be measured, R3.

This increases the resistance in the circuit and decreases the current.

Since the value of current through the meter depends on the value of external resistor R3, the scale can be calibrated in ohms, kilohms or megohms.



Note that:
(a) Full-scale deflection corresponds to zero resistance (short circuit).

(b) No deflection corresponds to an open circuit.

(c) The scale is non-linear. High resistance calibrations are cramped at the left-hand end.